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THE ST. LOUIS MEETING

Four half-day sessions for the reading of papers are being planned by the Division of Chemical Education for the St. Louis meeting of the American Chemical Society, April 16th–21st.

The first two of these will be devoted to a Symposium on the Teaching of Analytical Chemistry. This Symposium will be built around the topics listed below, each of which is to be introduced by a formal paper.

Objectives and Content of the Introductory College Course in Qualitative Analysis—J. H. Reedy, University of Illinois.

Objectives and Content of the Introductory College Course in Quantitative Analysis—H. H. Willard, University of Michigan.

Technic of Conducting the Introductory Course in Qualitative Analysis—N. H. Furman, Princeton University.

Technic of Conducting the Introductory Course in Quantitative Analysis—E. G. Mahin, Notre Dame University.

Qualitative Analysis in Secondary Schools—Theodore D. Kelsey, Grover Cleveland High School, St. Louis.

Quantitative Analysis in Secondary Schools—H. R. Smith, Lake View High School, Chicago.

Advanced Courses and Graduate Work in Analytical Chemistry—C. W. Foulk, Ohio State University.

Two half-days will be devoted to general papers. Titles for these papers should reach the Secretary not later than March 1st. According to a ruling of the Division, no title may be placed on the program unless an abstract of at least 100 words has been received. Abstracts should be furnished in duplicate. The author should indicate whether or not a lantern is desired, and also the approximate time required for the presentation of his paper.

The Senate and Division will hold luncheons on Monday and Tuesday, April 16th and 17th. High-school teachers of chemistry in the St. Louis area will be invited to the second luncheon.

It is planned to provide sleeping accommodations for undergraduate and graduate students in chemistry who attend the meeting. The charge, if any, will be nominal. Those wishing to avail themselves of this feature should address the Assistant Secretary of the Division, Dr. L. J. Wood, 1402 South Grand, St. Louis, Missouri.

R. A. BAKER, Syracuse University, *Secretary of the Division*

Atomic Structure Limits Accuracy of Measures. No matter how accurate and delicate human measuring devices may become, there is a definite limit beyond which measurements cannot be pushed. This is an effect of the structure of the atoms of matter themselves, Dr. Arthur E. Ruark, of the Mellon Institute at the University of Pittsburgh, told members of the American Physical Society recently. The reason for this, he said, is that the measuring devices themselves are always made up of atoms and are constantly changing.

"For example," said Dr. Ruark, "a measuring stick undergoes changes in length due to heat motions of the particles composing it and measurements of length made with its aid may not be pushed beyond a certain limiting accuracy even on the assumption that the observer is possessed of almost super-human skill."—*Science Service*

Sincerely
J. W. Farr

EDITOR'S OUTLOOK

President S. W. Parr

PROFESSOR Parr, newly elected president of the American Chemical Society, has been, for a generation, so familiar a figure at the meetings of the Society and of other scientific organizations that the portrait on the opposite page is presented as that of an old friend, rather than by way of introduction. His researches on the composition, characteristics, calorimetry, and utilization of coals, on acid-resisting alloys, and numerous other industrial problems are internationally known.

However, to quote Dr. W. A. Noyes, writing in the *Chemical Bulletin*, "Perhaps his finest contribution of all has been his work as a teacher. . . . Literally hundreds of students have come under the inspiration of his personal character and work. His kindly, practical advice to young men entering on careers as chemists will never be forgotten by many of them. His judgment of the qualifications of a student . . . . gave to his recommendations a unique value and his colleagues went to him for information about suitable candidates with great confidence in his ability to put the right man in the right place."

The qualities which have won for Professor Parr the universal respect of his associates as a scientist, a teacher, and a man are well summed up by Dr. D. F. McFarland, who says:

"Only those who have worked with Professor Parr can fully appreciate his unfailing good cheer, his unflagging industry and his stimulating example of service and study. Not only is he a research man of great accomplishment, but he is also a great teacher who is revered by many in the land for the inspiration which he has given them to search out and apply the truths of chemistry.

"Professor Parr's friends are legion and they rejoice that he has been placed in the position of highest honor in the American Chemical Society."

To all of which we may add the hope that the benefit of his services and the inspiration of his example may enrich American chemistry for many years.

The Abel Fund for Research

AMONG the recently announced endowments and gifts for the support of scientific research none is of greater interest to the general public than that entrusted by the Chemical Foundation to the Johns Hopkins University for the study of "the origin, nature and possible cure of the common cold." The total sum of $195,000, which is to constitute "The John J. Abel Fund for Research on the Common Cold," will be so dis-

tributed as to provide for the support of a five-year program of investigation.

The cold is an ailment with which we are all contemptuously familiar. Most of us have learned to accept it philosophically as one of the annoying but less serious ills to which mankind is inevitably heir. Like the sufferer from *mal de mer*, the victim of a cold may plumb the depths of abject misery, but he can usually expect only derision or, at best, mild sympathy from the unafflicted bystander. Once recovered, he, himself, is inclined to minimize his discomfiture and to dismiss the matter from his mind. As an experience which involves discomfort without necessarily leading to fatal or even serious results the common cold seems to fulfil the criteria of a subject for humor rather than those of an evil to be seriously combated.

Yet, but little reflection is necessary to convince one that, considered in the aggregate, colds must take an enormous annual toll in days lost from work, in decreased efficiency at work, in strained human relationships due to impaired dispositions, and in actual physical suffering. The economic loss alone has been estimated at millions of dollars yearly. Nor are the after-effects of colds by any means negligible. How often one hears of a serious illness which has been able to lay hold on its victim while his resistance was lowered by a cold. If total ravages, direct and indirect, are to be considered, rather than the severity of the ordinary individual case, surely the common cold can claim a prominent place in the list of human ailments.

We are not so naive as to suppose that the expenditure of certain thousands of dollars can be confidently counted upon to automatically eradicate such an evil from our midst. The present paucity of knowledge concerning the problem to be attacked is sufficient evidence of the difficulties to be encountered in its solution. We do believe, however, that the arrangement which has been consummated assures the most brilliant prospects of success that human forethought can provide. Dr. Abel's comment upon the projected research is illuminating in this connection. He says, in part:

"The problem which has been set to our investigation by Mr. Garvan, of the Chemical Foundation, can only be studied by the coöperative efforts of the clinician, the epidemiologist, the bacteriologist, the pathologist, the pharmacologist, the biochemist, and the physicist.

"Fortunately this spirit prevails in the various institutes of the Johns Hopkins University and I am confident that the problem will be attacked with energy, unremitting industry and in a generous spirit of mutual helpfulness by the several investigators into whose hands it will be given."

The faculty committee which has been appointed to administer the research work includes: Dr. Lewis H. Weed, dean of the School of

Medicine, *Chairman;* Dr. William H. Howell, director of the School of Hygiene and Public Health; Dr. Warfield T. Longcope, professor of medicine; Dr. Carroll G. Bull, professor of epidemiology; Dr. Samuel J. Crowe, professor of laryngology and otology; Dr. Lawrence H. Baker, executive secretary of the medical faculty.

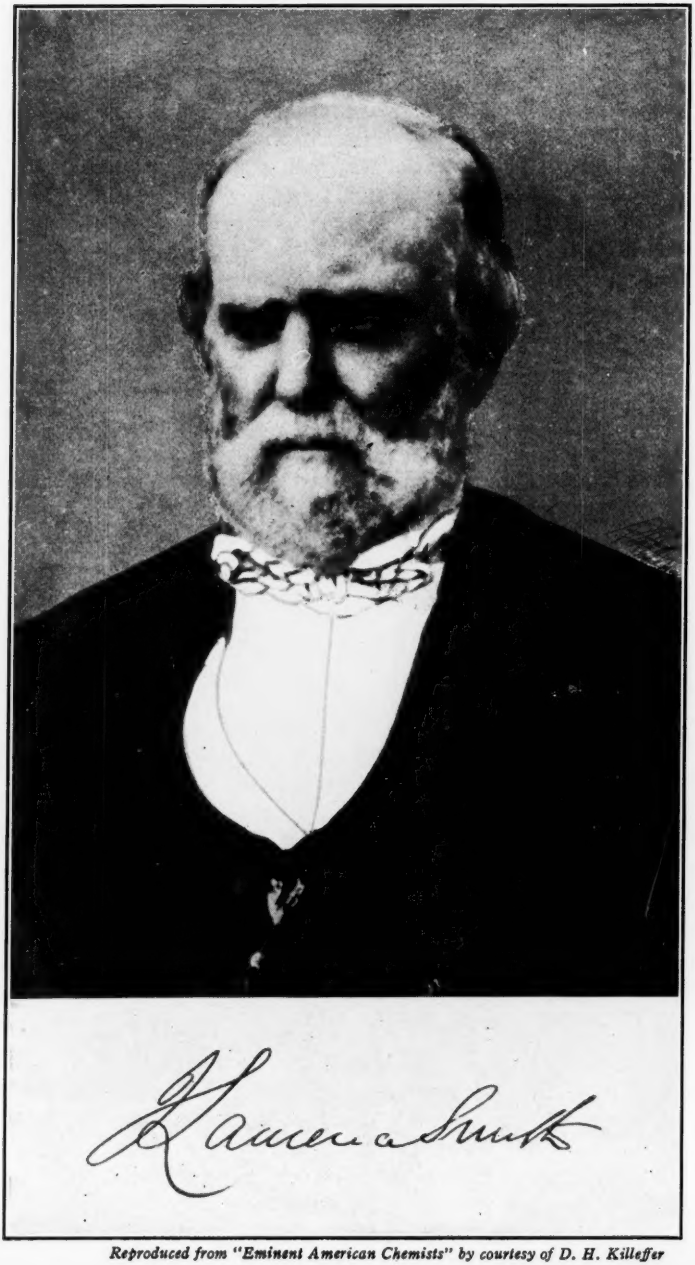
It is eminently fitting that the new fund should bear Dr. Abel's name, for, as Mr. Garvan said in the letter announcing the gift, he is "the man who, perhaps more than any other living scientist today, exemplifies the beneficial application of the science of chemistry to medical problems." A distinguished investigator is thus appropriately honored through the association of his name with a worthy and significant project. May that project prosper and reflect new glory upon him.

The St. Louis Meeting

THE spring meeting of the American Chemical Society will be held at St. Louis during the week of April 16th to 21st. The Division of Chemical Education is planning four half-day sessions, two of which will be devoted to a symposium on the teaching of analytical chemistry. The remaining two sessions will be occupied in the reading of general papers. A more detailed announcement from Secretary Baker appears on page 116 of this issue.

We are particularly glad to note that the Chemical Education luncheons which constituted so pleasant a feature of the Detroit meeting are to find a place on the St. Louis schedule. Such opportunities for the making and renewing of acquaintanceships and for the informal discussion of professional and other subjects should be provided at every meeting.

The continuation of the practice of supplying sleeping accommodations at nominal charges for graduate and undergraduate students is also worthy of commendation. The future strength of the Society resides in the students of today. No means whereby they may be encouraged to take an active interest in its affairs and enabled to attend its meetings should be neglected. The habits and associations thus formed will hereafter benefit both the students and the organization itself.



Reproduced from "Eminent American Chemists" by courtesy of D. H. Killeffer

J. LAWRENCE SMITH

John R. Sampey, Howard College, Birmingham, Alabama

J. Lawrence Smith was one of the first American chemists recognized and signally honored by European scientists. He was an international figure at the time of the founding of the American Chemical Society. The Smith fusion method for potassium and sodium is familiar to students of elementary quantitative analysis, but few experienced analysts realize how many of his contributions, set forth in one hundred and forty-five separate articles, remain in use, unmodified by the developments of the last fifty years. And only the close student of the history of our science gives Smith credit for the first comprehensive piece of research in organic chemistry undertaken by an American.

John Lawrence Smith was born near Charleston, South Carolina, December 17, 1818. He was such a precocious child that interest was early aroused in the old adage, "The child is father of the man." One biographer writes that, "such was his predilection for and proficiency in mathematics that, before he could read, and indeed when only four years old, he added and multiplied figures with singular rapidity, was in algebra at eight, and at the age of thirteen was already engaged in the study of calculus." He received his early training in the best private schools of Charleston, and at the age of sixteen he entered the University of Virginia, where for two years he studied civil engineering, natural philosophy, and chemistry.

His first choice of a profession did not suit his scientific tastes, and after a year as assistant engineer on the railroad between Charleston and Cincinnati he decided to enter the Medical College of the State of South Carolina located at Charleston. During the three years there he showed unmistakably for the first time that enthusiasm and ability which characterized his later work; he published two original pieces of research and completed a thesis on "The Compound Nature of Nitrogen," in the recognition of which he received from the faculty a silver goblet.

Immediately following graduation Smith went to Paris to continue his scientific studies. For a time he studied toxicology with Orfila, physics with Poulliet, Desprez and Ed Becquerel, mineralogy and geology with Dufrenoy and Élie de Beaumont, and chemistry with Dumas. A visit to the laboratory of Liebig at Giessen won this man of many interests so completely to chemistry that, with the exception of his numerous contributions to the closely allied science of mineralogy, Smith thereafter devoted all his resources to chemical investigations.

From Liebig he received the inspiration to attack the most formidable problem in organic chemistry yet undertaken by an American. He set for himself the task of determining the true nature of spermaceti, a problem which Chevreul, the father of the chemistry of fats, had failed to solve.

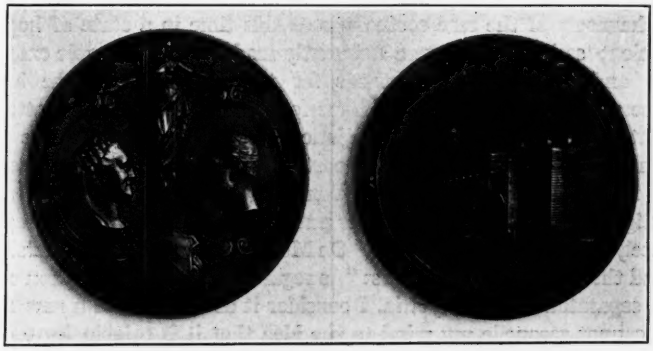
Smith appreciated the difficulties involved and in the opening paragraph of the paper setting forth the results of his investigation he writes, "Of all the fatty bodies that have been examined there is perhaps not one whose composition has been so imperfectly arrived at as that of spermaceti, and it is a little remarkable that Chevreul, with the accuracy which distinguishes his researches upon the fats, should not have ascertained more nearly its true composition." This paper received wide circulation in European journals, and marked the author as an investigator of unusual ability.

After three years in Europe, Smith returned to Charleston, and for a short time divided his attention between medicine and chemistry. He gave a series of lectures at the Medical College on toxicology, and in 1846 founded the *Medical and Surgical Journal of South Carolina*, associated with Dr. Sinclair. His major interests, however, remained in analytical chemistry, for during this period he not only accepted the position of State Assayer of the bullion that came in from the gold fields of Georgia, and North and South Carolina, but also devoted much attention to agricultural chemistry. He was the first to point out the large amount of calcium phosphate in the marl beds on which the city of Charleston rests. His investigations into the character of soils and culture affecting the growth of cotton were so thorough that when the Sultan of Turkey requested Secretary Buchanan to send American scientists to teach Turkish agriculturists methods of cotton growing, Smith was appointed on the commission.

When Smith arrived in Turkey in 1847 he was chagrined to find that an associate had already persuaded the government to adopt a method which he felt doomed to failure. He handed in his resignation and was on the point of leaving the country when the Turkish government induced him to accept an independent position as mining engineer. His discoveries, during the next four years, of emery, chrome ores, and coal brought rich revenues into that country's treasury, and at the same time placed Smith's name high on the roll of noted mineralogists. His first memoir on emery shows how his discovery of this valuable mineral in Asia Minor broke the monopoly of the island of Naxos; in the ten years from 1837–47 the price of emery advanced from forty dollars a ton to one hundred and fifty; in less than three years after the Turkish mines were opened the price had fallen to fifty dollars a ton. The subsequent discovery of this mineral in America was the direct result of this memoir on emery and its associate minerals.

In the spring of 1850 Smith left the Ottoman government and went to Paris where he presented two memoirs on emery to the Institute. Here he began work on his widely used inverted microscope. Returning to America he served short terms as professor of chemistry in the University of Louisiana, the University of Virginia, and the University of Louisville. These academic duties were distasteful to the man who found so much

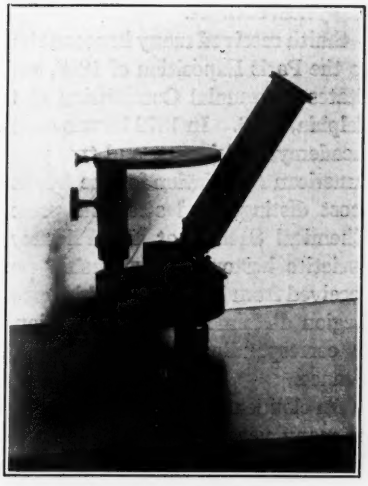
inspiration in travel and who delighted in prosecuting his researches with his own hands. Like the great Frenchman Lecoq de Boisbaudran, the



Medal Awarded to Dr. Smith by the Turkish Government at the Completion of His Four Years of Service in the Empire

discoverer of the rare earths gallium, samarium, and dysprosium, J. Lawrence Smith worked without help from assistants or students. It is a tribute to the tireless energy of the man that his original researches fill more than six hundred pages.

In 1852 he married the daughter of the Hon. James Guthrie, who was Secretary of the Treasury under President Buchanan. Louisville became his home, and during the last thirty years of his life he performed most of his important analytical work in his private laboratory. The analysis of meteors occupied a large part of his time, and between 1854–72 he published twenty-two papers on the subject. He also conducted extensive investigations on American minerals; through painstaking analyses he determined for the first time the chemical formulas of a number of minerals, and in addition had the honor of discovering several new ones. It was while working with the



The Smith Inverted Microscope

samarskite of North Carolina that Smith announced to the Academy of Natural Sciences, May 8, 1877, the discovery of a new element. He named the element Mosandrum, in honor of the important labors of the distinguished chemist Mosander in the field of the rare earths. The chemistry of the rare earths was at this time in a state of hopeless confusion; serious errors were frequently made in spectroscopic examinations, and the chemical methods for the separation of the known members of the rare earths were imperfectly developed. Smith attacked the latter problem with characteristic thoroughness, and it was upon the analytical reactions of the rare earths in samarskite that he based his claim for the discovery of the new element. He was in the midst of this investigation when the Grim Reaper put an end to his labors. In a paper privately printed, Louisville, 1883, "On Methods of Analyzing Samarskite," we find these concluding remarks: "As regards the principal portion of the earth separated from the yttria, I consider it as an oxide of a new earth, for I cannot reconcile my mind to the idea that it is principally terbia." And then this tragic line, "Owing to the fact of bodily indisposition I have not been able to continue my researches on these earths." It remained for another generation, equipped with far more accurate methods of spectroscopic examination, to unravel the chemistry of the rare earths, but the efforts of J. Lawrence Smith, on "chemical grounds," as he called it, towards the solution of the problem stand as a memorial to his genius as an analytical chemist.

Smith received many honors at home and abroad. He was commissioner to the Paris Exposition of 1867, and he received a medal from the United States Centennial Commission at the International Exhibition at Philadelphia, 1876. In 1872 he was elected a member of the American National Academy of Sciences, and two years later he was elected president of the American Association for the Advancement of Science. He was one of the most distinguished scientists present at the founding of the American Chemical Society at the Priestley Home. More than a dozen foreign societies bestowed membership upon him, but the two highest honors received from Europe were his appointment to the rank of chevalier of the Legion d'Honneur and his election in 1879 to succeed Sir Charles Lyell as corresponding member of the Academy of Science of the Institute of France.

An eloquent tribute to Smith's private life has been written by his friend of many years, Dr. J. B. Marvin, a prominent physician of Louisville. Dr. Marvin concludes his biographical sketch with these paragraphs:

"Prof. Smith was of imposing presence and great dignity, strong, manly, self-reliant, pure-hearted, withal one of the most modest, unostentatious of men; a simple, genial Christian gentleman. To those who knew him, or ever felt the charm of his presence, he was scarcely less endeared by his

MEDAL AWARDED TO DR. SMITH BY THE UNITED STATES CENTENNIAL COMMISSION, 1876

genial virtues than admired for his great powers. In him were united great talents and profound knowledge, with such graces of character as modest unselfishness and the most spotless integrity. His hospitality was unbounded; his love for children great; his courtesy and gallantry to ladies partook of the chivalry of former ages. He was generous with his apparatus, and any one manifesting an interest in science was sure of help and encouragement from him. For many years he was a consistent member of the Walnut Street Baptist Church. He was active in every benevolent and charitable work. His charity knew no sect nor creed, but his ear and purse were open to all real suffering. He founded and largely endowed

J. LAWRENCE SMITH MEMORIAL MEDAL, AWARDED NOT OFTENER THAN ONCE IN TWO YEARS, BY THE NATIONAL ACADEMY OF SCIENCES, TO THE PERSON MAKING THE MOST IMPORTANT ADVANCE IN THE STUDY OF METEORIC BODIES.

the Baptists' Orphans Home of Louisville, thereby erecting a monument more noble and enduring than marble or brass.

"Prof. Smith said, 'Life has been very sweet to me. It comforts me. How I pity those to whom memory brings no pleasure.' He had 'set his house in order,' saying he knew it would be but a short time before death would claim him; but he was ready to go at any hour or day. He leaves the memory of a pure life and a heart full of 'exercized humanity.' "

Prof. Edgar F. Smith in his book on "Chemistry in America" places the names of J. Lawrence Smith, Wolcott Gibbs, and Frederick A. Genth in the forefront of American chemistry; in his own words, to him "it has always seemed as if there could not be too much credit given Genth, Gibbs and J. Lawrence Smith for the admirable contributions they made to the development of chemical science in the United States."

Democratic Control of Education Called Evil by Tennessee Teacher. Dr. Herbert C. Sanborn of Vanderbilt University, speaking before the American Association for the Advancement of Science recently, severely criticized many of the tendencies of education under its present control.

"Education in America has passed from sectarian control to that of industrial democracy with results the disastrous nature of which is now only too evident," he declared. "The competition of colleges in education has resulted in advertising methods on the part of institutions and teachers that have been at times as unscrupulous as those of big business at its worst. By means of the elective system there has been a watering of educational stock and a traffic in academic degrees, like that which once prevailed in the field of medicine, in order to meet the demands of the masses for signs of distinction that have come to lose whatever meaning they may once have possessed. In addition to this the function of the educator has come to be restricted by democracy in many ways that are injurious and even positively vicious."

The remedy for the ills he assailed lies, in Dr. Sanborn's opinion, in the capture of the control of education by educators, and he advocated that steps be taken by the men and women who have devoted their lives to instruction and the guidance of research toward becoming masters of their own working conditions.—*Science Service*

Drug Production Increased by Ultra-Violet Light. Ultra-violet radiation, now widely used for the promotion of human health, has been shown to be able to promote plant growth as well, and to increase the production of valuable plant ingredients. Experiments in this field were reported before the Botanical Society of America by Adelia McCrea, of Parke, Davis and Company, Detroit.

Miss McCrea planted two crops of foxglove plants, from which the widely used drug digitalis is made. Part of each crop was started under ordinary glass, which shuts out ultra-violet light, and the rest under special glass which transmits ultra-violet. The young plants under the ultra-violet responded at once, forming new leaves faster than the others did.

After they were transferred out of doors and grown to maturity under similar conditions, both crops were put through the process for extracting the drug. The irradiated plants yielded an extract of notably higher potency than the untreated controls; in the second crop the increase amounted to as much as 35 per cent.—*Science Service*

IMPORTANCE OF PHYSICAL INVESTIGATIONS IN THE STUDY OF THE CONSTITUTION OF WOOD

ALFRED J. STAMM, U. S. FOREST PRODUCTS LABORATORY, MADISON, WISCONSIN

Upon first consideration it might seem peculiar that so important a structural material as wood, with its numerous technical uses and possibilities, should be so incompletely known in its fundamental chemical and physical aspects. The prevailing dearth of knowledge is not due, however, to a lack of interest or effort extended, but rather to the complexity of the material, and to a lack of variety or at least of correlation in the methods of attacking the problem. In this article an attempt will be made to show the scope of the known facts about wood, and to suggest further possible lines of research which may be of value in advancing and correlating our knowledge on this subject.

Proximate Chemical Analysis of Wood

Until recently almost all fundamental studies of the chemistry of wood have been undertaken from a strictly analytical point of view. Taken alone, analytical data fall far short of furnishing information demanded by present scientific and technical developments in this field. Hawley and Wise[1] point out repeatedly the inadequacy of analytical methods to give definite information as to the chemical structure or even the chemical nature of the original constituents. The drastic treatment required to effect the solution and separation of the various compounds may very readily cause chemical changes in any or all of them. As a matter of fact, the conventional proximate analysis of wood is expressed in terms of certain more or less arbitrary products which result from various definite procedures of separation but which in themselves are rarely pure chemical entities. Further chemical treatment often results in their separation into fractions differing more or less in properties. The question thus arises, is the wood itself actually made up of a relatively small number of definite compounds which are partially decomposed in the process of separation to form a larger number of intermediate compounds, or is it made up of all of these compounds, part of which differ only slightly from each other?

To be more specific, the components of wood as obtained by the customary analytical separations can be classified under the following groups: extractives, dilute-alkali-soluble material, Cross and Bevan cellulose, total pentosans, pentosans in cellulose, and lignin.[1,2] The accompanying table gives the proximate analysis of a few woods to show the relative amounts of these more or less arbitrarily isolated components. There is a certain amount of overlapping of the fractions, so that the results are by no

[1] "Chemistry of Wood," Chemical Catalog Co., 1926.

[2] Schorger, "Chemistry of Cellulose and Wood," McGraw-Hill Book Company, 1926.

TABLE I

PROXIMATE ANALYSES OF WOODS (MEAN VALUES OBTAINED BY THE U. S. FOREST PRODUCTS LABORATORY)
(Results in percentage of oven-dry (105°C.) samples)

Species	Ash	Solubility in			Acetic acid	Meth-oxy	Pento-san	Cellu-lose	Lig-nin	In Cellulose			
		Cold water	Ether	1 per cent NaOH						Pento-san	α Cellu-lose	β Cellu-lose	γ Cellu-lose
Softwoods:													
Western Yellow Pine	0.46	4.09	8.52	20.30	1.09	4.49	7.35	57.41	23.65	6.82	62.10	10.56	30.13
Yellow Cedar	0.43	2.47	2.55	13.41	1.59	5.25	7.87	53.86	31.32	7.30	62.68	11.06	26.25
Redwood	0.21	7.36	1.07	20.00	1.08	5.21	7.80	48.45	34.21	7.40	78.81	2.95	18.24
Douglas fir	0.38	3.54	1.02	16.11	1.04	4.95	6.02	61.47	...	5.34	...	...	...
Hardwoods:													
Tanbark Oak	0.83	4.10	0.80	23.96	5.23	5.74	19.59	58.03	24.85	22.82	56.77	19.92	23.03
Hickory	0.69	4.78	0.63	19.04	2.51	5.63	18.82	56.22	23.44	21.89	76.32	2.82	20.35
Yellow Birch	0.52	2.67	0.69	19.85	4.30	6.07	24.63	61.31	...	28.30	...	...	...
Sugar Maple	0.44	2.65	0.25	17.64	4.46	7.25	21.71	60.78	...	24.48	...	...	...

means summative. Special determinations, such as that of "methoxyl" content and acetic acid generated by treatment of the wood with dilute sulfuric acid, may also be made.

The water-soluble material consists largely of tannins and carbohydrates, and the ether extractives consist mainly of fatty substances and resins. The alkali-soluble material is rather less definite, consisting of pentosans and other carbohydrates, together with part of the so-called lignin.

The pentosans are not isolated as such but are determined in the original wood and in the Cross and Bevan cellulose by hydrolysis to pentose sugars and conversion in the presence of hydrochloric acid into furfural, which is then precipitated as furfural phloroglucide with phloroglucinol.

The lignin is isolated from wood by the solution and hydrolysis of the cellulose and other carbohydrates in 72 per cent sulfuric acid. The resulting residue, so-called lignin, is a quite arbitrary fraction. That it may vary considerably in composition is indicated by variations in methoxyl content. Further, some of it may be removed by the drastic acid treatment. As pure lignin has never been isolated, its exact empirical formula as well as its structural formula are still unknown. Most of the speculative formulas are of the hydro-aromatic type containing furan rings.

Cellulose is the component of wood that is of chief industrial importance. Its theoretical characterization, however, still lags behind its technical application so as to hamper further technical developments. Cross and Bevan cellulose, so named from the two English chemists who originated the determination, is a residue which remains after removing the lignin from the extractive-free wood by chlorination and treatment with sodium sulfite. It contains what appears to be true cellulose together with a large part of the pentosans and other carbohydrates of the wood, such as mannans, galactans, and very probably glucosans. Cross and Bevan cellulose also differs from cotton cellulose in its solubility in sodium hydroxide. The α-cellulose is insoluble in 17.5 per cent sodium hydroxide; the β-cellulose is soluble in alkali but can be reprecipitated with acetic acid, and the γ-cellulose is soluble in alkali and is not reprecipitated by the acid. Cotton cellulose, being largely α, is little affected by alkalies, whereas wood cellulose is considerably affected (see table). The difference in solubility is at least partially due to the presence of the other carbohydrates in the β and γ fractions of the wood cellulose, but even after they are as completely removed as possible some difference still remains. It is not necessary to infer, however, that there must be some definite chemical difference between cotton and wood cellulose. The difference in solubility between the two may be due to differences in dispersion or hydration, with a consequent difference in the degree to which the secondary valences may be saturated by sodium hydroxide or water.

X-Ray Methods

From the foregoing it will be seen that our knowledge of the composition of wood cellulose is as yet far from exact. Any physical method that promises new information, therefore, holds great interest. Recent x-ray studies throw some light on this question. According to Herzog and Jancke,[3] the x-ray diagrams of cotton cellulose, ramie cellulose, and wood pulps reveal the same crystal system and the same axial ratios, thus strongly indicating a chemical identity. Similar studies of Cross and Bevan cellulose and cotton cellulose subjected to appropriate treatments should show to just what extent cellulose is modified during the course of isolation. Furthermore, x-ray studies have been of great value recently

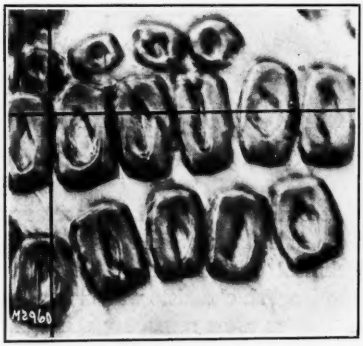


FIG. 1.—CROSS-SECTION OF SOFTWOOD TRACHEIDS FROM WHICH THE LIGNIN MIDDLE LAMELLA HAS BEEN DISSOLVED.

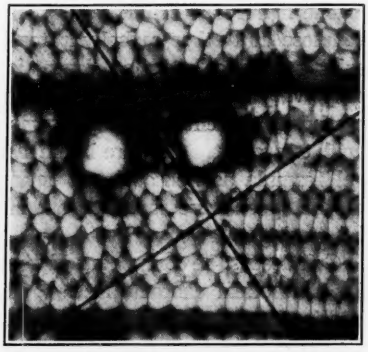


FIG. 2.—CROSS-SECTION OF HARDWOOD MIDDLE LAMELLA FROM WHICH THE CELLULOSE CELLS HAVE BEEN DISSOLVED. THE DARK HORIZONTAL LINES ARE RAY CELLS.

in the determination of the actual structural formula of pure cellulose. Sponsler and Dore[4] have shown with a fair degree of definiteness, by combining the information from x-ray studies, analytical data, and physical properties, that ramie cellulose has an amylene oxide linkage within the structural glucose unit ($C_6H_{10}O_5$), and that these units are joined together in the longitudinal direction of the fibers by primary valences and in the other two directions by secondary valences.

Microchemical Studies

Recent studies with the microscope by Ritter[5] of the Forest Products Laboratory are throwing some light on the distribution of the chemical

[3] *Papier Fabr.*, **23,** 121 (1925).

[4] Colloid Symposium Monograph, Vol. IV, p. 174, **1926,** Chemical Catalog Co.

[5] *Ind. Eng. Chem.*, **17,** 1194 (1925).

constituents in wood. In this work Ritter applies the ordinary methods of analytical separation to microsections of wood and observes what part of the physical structure is most readily attacked. The investigation has thus far shown that the middle lamella (the part of the structure between cell walls) is probably all lignin—that is, it dissolves on chlorination and treatment with sodium sulfite. Treatment with 72 per cent sulfuric acid dissolves the cell walls, leaving the middle lamella network intact (see Figs. 1 and 2). A further finely divided unattached residue also is left, indicating that some lignin is very likely associated with the cellulose and other carbohydrates in the cell wall. Further studies along the same line should reveal the relative composition of other structural elements of wood.

Advance of Chemical Knowledge through Broadened Research

Although present analytical methods do not accurately characterize the constitution of wood, they afford a means of comparing different kinds of wood; hardwoods with softwoods, sapwood (the outer portion of the tree trunk) with heartwood (the inner core). They enable one to trace the process of decay. They furnish a means, however imperfect as yet, of relating chemical to physical properties. More accurate analytical methods and means of characterizing the constituents of wood are needed. X-ray studies should yield much new information. They will very likely be of great importance in the characterization of lignin, and may lead to the determination of its structural formula and possibly the manner in which it is combined with cellulose in the cell wall. A correlation of this information with that from double refraction studies should also yield some important information. A study of the colloidal dispersion and hydration of the various isolated residues may show that some of the seemingly chemical differences are entirely physical. Studies of peptization and coagulation may reveal new methods of purification which will insure more complete removal of adsorbed substances.

Physical Properties

Microscopic Structure and Mechanical Strength

Because of the fact that most of the uses of wood are dependent upon its physical properties, their correlation is of great importance, though some of the properties may have only a minor bearing on the chemical nature of wood. The structural and mechanical properties of wood are among the chief physical properties that have been studied. Microscopic examination[6] has led to a rather exact differentiation between the struc-

[6] Koehler, "Guide Book for Identification of Woods Used for Ties and Timbers," U. S. Dept. of Agriculture, Forest Service, 1917.

tural features of different species of wood. Figures 3 and 4, respectively, show the chief structural differences between the two general classes of wood, namely softwoods or conifers, and hardwoods. These drawings, representing cubes of wood less than a quarter of an inch on a side, were made by the Wood Technology Department of the Forest Products Laboratory. They show the detail better than a microscopic section, as it is almost

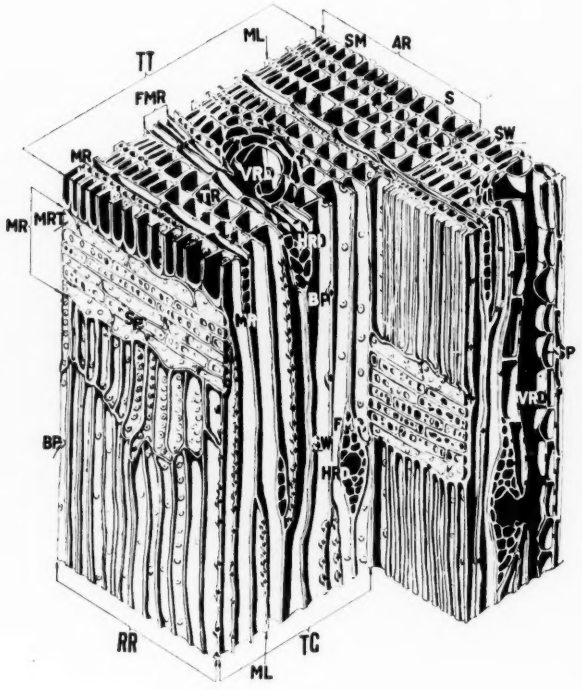


FIGURE 3

impossible to bring all of the structural features into focus at the same time.

The tops of the blocks represent transverse sections of the wood. The rectangular units which make up this surface in the softwoods (Fig. 3) are sections through vertical cells, mostly tracheids or water carriers, *TR*, the walls of which form the bulk of the wood substance. Vertical resin ducts, *VRD*, of variable size and frequency of occurrence are dispersed among the cells. Springwood cells, *S*, have a greater cavity cross-section (*lumen*) than the summerwood cells, *SM*, and a correspondingly thinner

wall. Together the springwood and summerwood cells make up the annual ring *AR*.

The larger openings, *P*, on the transverse section of the hardwoods (Fig. 4) are sap-conducting vessels, or pores, built up of short cylindrical cells joined to one another at the ends. The presence of these pores, which in

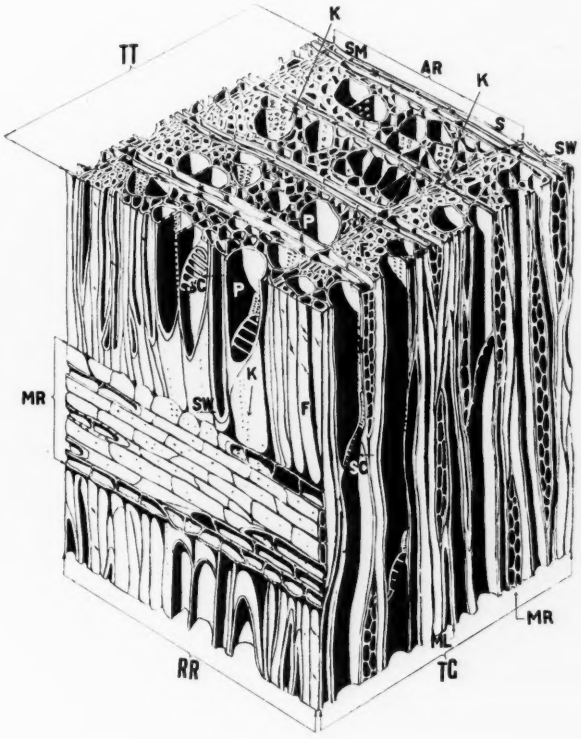


FIGURE 4

many species are visible without the aid of a lens, help to distinguish a hardwood from a softwood. The pores are usually larger and more numerous in the springwood, *S*, than in the summerwood, *SM*. In both types of wood the cementing material between the various cell units, middle lamella, *ML*, consists of lignin, as previously cited.

The surface, *RR*, in both figures represents a vertical plane along the radius of the trunk. This surface, commonly called "edge grain" in softwoods and "quartersawed" in hardwoods, is not so distinctively marked in soft-

woods as in hardwoods. In some hardwoods, the "quartered" surface with its large lustrous "flakes" formed by the medullary rays, *MR*, entering and leaving the plane of the saw is valued because of the attractive figure. Medullary rays, *MR*, also occur in the softwoods and are shown in cross section on the tangential faces, *TG*. These serve to store and to distribute horizontally the food material of the tree. Some of the rays contain horizontal resin ducts, *HRD* (Fig. 3).

The simple pits, *SP*, and bordered pits, *BP*, seen in section on the surface, *TG*, of the softwoods (Fig. 3) serve for communication from tracheid to ray cell and tracheid to tracheid, respectively. The hardwood pits are represented by *K* in Figure 4.

Microscopic examination of sections cut in each of the three different structural directions has led to a rather exact differentiation between the structure of different species and has resulted in the development of a ready means of identifying different kinds of wood. However, more quantitative statistical data as to the lengths, cross section and number of the various structural features per unit of volume or cross-section, and a correlation of these as far as possible with other physical properties, would be desirable.

Mechanical strength studies are of immediate practical value. Because of the large variations in strength of the different specimens of a single species, and the rather large number of variables that have to be considered, this study has become quite complicated and has required statistical treatment in the analysis of the results. In spite of this it has been possible to develop several interesting generalizations. Roughly speaking, the strength of a given species increases with an increase in density[7] and with increased degree of seasoning. Tiemann[8] has shown that there is practically no change in the strength of a wood specimen upon drying until the fiber saturation point is reached (the moisture content at which the bound water is a maximum and free water is entirely absent). Below this moisture content the strength increases rather rapidly with a decrease in moisture content provided honeycombing, etc., are avoided.

Density

The densities of wood and of wood substance are of considerable interest. The former have quite a broad range of variation. Light woods like balsa sometimes run as low as 0.1 g. per cc. on a kiln-dry basis and lignum vitae as high as 1.2 g. per cc. Most common woods have densities between 0.3 and 0.5 g. per cc. There is no known relationship between the chemical

[7] Newlin and Wilson, United States Department of Agriculture, *Forest Service Bull.*, **676** (1919).

[8] United States Department Agriculture, *Forest Service Bull.*, **70**, 82 (1906). U. S. Dept. Agr., *Forest Service Circular*, **108** (1907).

composition of the wood itself (extractive free) and the density. The differences seem to be entirely due to differences in porosity and in the amount of extraneous material which can be extracted. This view is, in general, confirmed by the fact that the density of wood substance is practically constant for all of the species. Measurements of the density of wood substance made by liquid displacement of fine wood sawdust in Gay-Lussac picnometers gave 1.51–1.55 g. per cc. with pure water for all of the woods tested.[9] Obtaining the volume of the wood substance by displacement with helium gas also gave similar results. A large number of non-polar organic liquids gave 1.47–1.48 g. per cc. Aqueous electrolyte solutions gave lower values than pure water. The results indicate that the differences between the values obtained with water and with the non-polar liquids are due to an incomplete absorption of the non-polar liquid by the finest wood structure.

Hygroscopicity

Wood is quite hygroscopic. Small specimens with a large readily accessible surface area respond in moisture content changes rather readily upon changing the humidity. In general, wood takes up about 5 per cent moisture in equilibrium, with 20 per cent relative humidity at room temperature, 10 per cent in equilibrium with 50 per cent relative humidity, 17 per cent in equilibrium with 80 per cent relative humidity, and 20–35 per cent in equilibrium with saturated vapor. This last point cannot be determined with any degree of accuracy because the very slightest drop in temperature of the wood will bring it below the dew point, and free moisture will condense on the surface. This equilibrium condition, which seems to vary somewhat between species, apparently corresponds to the fiber saturation point, at which there is a sharp break in the strength-moisture content curves. When a specimen of wood is at its equilibrium moisture content, the vapor pressure of the water within and outside are the same. It is thus evident that wood has the power of reducing the vapor pressure of water. From theoretical considerations it can be shown that this reduction of vapor pressure will only become appreciable in structure finer than that which can be seen under the highest powered microscope. This is in agreement with the fact that all species come to about the same moisture content for all humidities below saturation, as present indications show that the large variations in capillarity or porosity of different species are entirely within the microscopic range of dimensions. Experiments seem to indicate, however, that excessive drying of wood permanently reduces its hygroscopicity, and likewise permanently reduces its strength.

Electrical Conductivity

The electrical conductivity of wood is chiefly a function of its moisture

[9] Stamm, unpublished data of Forest Products Laboratory.

content though it is slightly affected by variations of density, natural ash content, and by the direction of flow of the current (conductivity twice as great longitudinally as tangentially or radially).[10] Bone-dry wood is a very good insulator, having a specific electrical resistance of as high as 1×10^{11} ohms. Saturated wood has a resistance similar to that of pure water (1×10^5 to 1×10^6 ohms). The logarithm of the electrical resistance is practically a straight line function of the moisture content from bone-dry to the fiber saturation point. Above this moisture content the change in electrical resistance is slight, indicating that the electrical conductivity is very likely an internal surface phenomenon. The fiber saturation points of different species of wood have been determined by Myer and Rees[11] in this way by determining the moisture content at which there is a break in the conductivity curve.

Swelling and Shrinking

Perhaps the most undesirable physical property of wood is its swelling and shrinking. In spite of the importance of this property, very little fundamental work has been done along this line. The problem is a difficult one because of the nature of the opposing forces. The natural tendency for wood to swell under any set of conditions is offset by mechanical forces and strains which exist in the wood or upon its surface as well as being affected by the wood structure itself. This can be well illustrated by an experiment made by Tiemann of the Forest Products Laboratory.[12] A piece of dry wood is clamped in a mechanical device so that its external dimensions cannot change. The specimen is placed in saturated air or in water, and is allowed to absorb as much water as it will take up. It is then removed from the clamp and allowed to dry. The specimen will shrink practically the same amount that it would have if previously allowed to swell freely while taking up water. The piece of wood can again be placed in the clamp and the process repeated. This has been done about ten times with a total reduction of the volume of the specimen to less than two-thirds of its original value. Presumably the normal swelling took place in the wood without being transmitted to the external dimensions. That is, the cells must have checked or been distorted so that the swelling could take place inward into the cell cavities and other voids in the structure. Subsequent drying without external restraint then gave the normal reduction of the external dimensions.

This same sort of thing takes place to a lesser degree for all specimens that are dried or soaked. It is this property which causes much of the warping and surface checking of wood during the process of seasoning, and

[10] Hasselblatt, *Z. anorg. allgem. Chem.*, **154,** 375 (1926). Stamm, *Ind. Eng. Chem.*, **19,** 1021 (1927).

[11] *Tech. Bull.*, N. Y. State College of Forestry, No. 19, Vol. **26** (1926).

[12] "Does Paint Preserve Wood?" *Sci. Am.*, May, **1924.**

upon subsequent exposure to variable weather conditions.[13] The outer surface of a wet board dries down below the fiber saturation point while the center is still saturated. It tends to shrink but is restrained by the center which shows no tendency to shrink. This strain tends to produce checks in the outer surface, but it is seldom fully relieved in this way so that when the outer surface becomes fairly dry and sets, that is, it no longer tends to change dimensions, it sets in tension. By this time the center of the specimen is getting below the fiber saturation point and it now tends to shrink, but the outer surface restrains the shrinkage, again causing a tendency for warping and checking of the interior. The so-called decay of a wood shingle roof is really a mechanical disintegration or an extreme case of checking as described above, caused by intermittent shrinking and swelling when the shingles are not prevented from ready absorption of rain water by a protective coating.

Another similar experiment by Tiemann is quite useful in straightening warped boards. Alcohol is applied to the convex side of the board with a brush, the surface being kept moist for a length of time depending upon the amount of straightening required. This surface tends to swell and warp the board still more, but the external swelling is largely prevented by the other face which has no tendency to swell. The swelling is thus almost all internal. On drying again this moist face tends to shrink just as though it had swollen normally, thus applying the necessary tension to straighten the board.

The swelling and shrinking of wood as transmitted to the external dimensions of small specimens varies in the three structural directions. In the tangential direction (tangent to annual rings) the shrinkage from green to oven dry condition varies from about 6.0–12.0 per cent. In the radial direction (from center of the tree to periphery) the shrinkage varies from about 3.0 to 7.0 per cent and in the longitudinal direction (parallel to the fibers) it is only a small fraction of a per cent. The fact that the longitudinal swelling and shrinking is almost negligible in comparison with that in the other two space directions conforms well with Sponsler and Dore's structure of cellulose. The chains of glucose units are continuous in the longitudinal direction but are held together only by secondary valences in the other two space directions, thus allowing extension subsequent to saturation of these secondary valences by water, that is, water may separate these chains of molecular dimensions.

Wood swells more in water than in any other liquid which has been tried. In alcohol and glycerine, the swelling is somewhat less and in nonpolar liquids practically negligible.[14]

There are great possibilities for further research on this problem of

[13] Tiemann, "Phenomena of Drying Wood," *J. Franklin Inst.*, July, **1919,** 27–50.
[14] Hasselblatt, *loc. cit.*

swelling. The development of a method of measuring the unrestrained swelling of wood substance and the correlation with this of the actual swelling transmitted to the external dimensions of different sized specimens under different set and retarding conditions might lead to a theoretical means of predicting the amount of swelling of different specimens under different conditions. Studies of the effect of various aqueous solutions on swelling might lead to a means of treating wood with a material that would appreciably cut down the original shrinkage from the green condition.

Passage of Liquids

The problem of the movement of liquids through wood is of great importance in seasoning of wood, impregnation with preservatives, permanence of the preservatives in the wood, and also in gluing and painting studies. Only recently has this problem been attacked from a theoretical standpoint. Several investigators are working on the problem at the U. S. Forest Products Laboratory under various experimental conditions. The work so far shows that at least three different types of flow are possible under various conditions; namely, bulk liquid flow, vapor flow, and flow of hygroscopic moisture. An attempt is now being made to show under just what conditions, and for which structural directions of flow through the wood the various types of flow predominate. The author has studied the movement of free water through wood under an electrical potential.[15] The steady state movement of water through wood (two opposite faces held in equilibrium with different relative humidities) has been studied by Stillwell[16] and Martley,[17] and the resulting moisture gradients have been roughly determined.

Miscellaneous

Several other physical properties of wood have been studied but by no means exhaustively. The total heat of wetting of wood by water has been found to vary but slightly between species, ranging from about 15–19 calories per gram of dry wood at 0°C. The specific heat of different woods is about 0.325 between 0° and 100°C.[18] The calorific value of dry wood is about constant, ranging from 8400–8800 B. t. u.[19] The contact potential between wood and distilled water seems to be constant for different species (0.0136 volt) and does not vary greatly from that of cotton cellulose against water (0.0157 volt).[15] The dielectric constant increases with an increase in moisture content. For dry wood it is about 2.5 parallel to the fibers and 3.6 across the fibers.

[15] Colloid Symposium Monograph, Vol. IV, p. 246, **1926**; Vol. V, Chapt. 23, **1927**, Chemical Catalog Company.

[16] *Tech. Paper* No. 1, Dept. Sci. Ind. Research, Forest Products, London, **1926.**

[17] *Tech. Paper* No. 2, Dept. Sci. Ind. Research, Forest Products, London, **1926.**

[18] Dunlap, U. S. Dept. of Agr., *Forest Service Bull.* **110** (1912).

[19] Parr and Davidson, *Ind. Eng. Chem.*, **14**, 935 (1922).

Summary

This summary of the physical and chemical properties of wood shows that a large amount of experimental work must be done before wood can be completely characterized, and the interrelationship of all of its properties understood. The situation looks hopeful, however, when it is observed that practically all of the physical information which is available, and which has already helped greatly in the solution of the interrelated problems has been collected very recently (see dates on references given). It seems reasonable to suppose that further experimentation along physical lines will be one of the chief factors if not the chief factor in solving the problems of the characterization of wood. Here as in all other fields of scientific endeavor, however, care must be taken not to lay aside any of the old tools or methods of procedure merely because others for the time being may be more productive of new scientific information.

Germ-Killing Powers of Smoke Studied. Determination of the efficacy of smoke as a germ killer is the object of a series of experiments recently reported by Dr. Ernest Hess of the Biological Board of Canada to the Society of American Bacteriologists at Rochester, N. Y.

Increases in the amount of air admitted per hour to the smoke producer caused uniformly a greater reduction of bacteria as well as "thicker" smoke. Smoke from different types of wood showed practically no difference in bactericidal power after six hours' action upon the test organisms, Dr. Hess stated. The tests were undertaken to get some sort of check on the value of smoke-curing as a means of preserving fish.

Dr. David L. Belding of Boston University reported the isolation of the causative organism of a blood infection of fishes that has caused serious losses among the fish of New England and Middle Atlantic States. The infection seems peculiar to cold-blooded animals. While no satisfactory preventive treatment has been discovered, some epidemics have been held under control in hatcheries by keeping the water below 55 degrees Fahrenheit.—*Science Service*

Tests Fail to Predict Students' Grades. College students must continue to submit to the painful process of taking examinations in order that their teachers may determine their achievement. Experiments to predict what they would do in psychology courses by psychological tests given in advance have not met with success. Before the section of psychology of the American Association for the Advancement of Science, Dr. Joseph Peterson, of the George Peabody College for Teachers, told of his researches.

The experiments were made with two hundred sophomore students, with either one, two, or three different tests, but practically no correlation was found between the success in the tests and the students' final grades.

Professor Peterson thinks that the diverse interests and social activities of the students account for this failure of the tests in prediction. In other words, he says, "other things than intelligence (given enough intelligence for one to become a sophomore college student) have important rôles in determining success in psychology classes as measured by the examinations. This is probably true also for any other college subject."—*Science Service*

THE POSSIBLE OVER-EMPHASIS OF LABORATORY INSTRUCTION IN HIGHER INSTITUTIONS

WALTER W. LUCASSE, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PENNSYLVANIA

The matter of laboratory instruction introduces difficulties in both the smaller and larger institutions of higher learning. In the one we find the student-assistant with his lack of age and chemical background or the young graduate who, if he is of the more capable type, is restlessly awaiting his opportunity to go elsewhere to pursue higher training. In the other we see the graduate student, naturally more interested in himself than in inspiring teaching or the boredom of the mechanics of mass education, helping to defray his expenses by correcting notebooks and ostensibly supervising laboratory. Meanwhile, through the back of his head pass questionings as to whether he will ever be able to master enough of the last lecture to make a sufficiently creditable showing in that chamber of horrors from which he may be admitted at last into the "fellowship of the society of scholars." Due to the ever-increasing cost of apparatus, materials, and stockroom service, the financial burden of laboratory maintenance in both types of institutions, except in rare instances, introduces a real problem. Again, with the natural limitation—pedagogical, manipulative, or financial—to certain kinds of experiments and the consequent necessity to round out the course in other ways into the semblance of a comprehensive survey of the field, there is the ever-present problem of keeping the subject-matter of two methods of instruction, laboratory and lecture, in proper emphasis, sequence, and coördination. Further, the problem has been greatly complicated in recent years by the large influx of students not specializing in chemistry.

Yet in spite of these and other attendant difficulties, we seldom question whether the game is worth the candle. In keeping with the spirit of the age we build bigger and better laboratories. Each branch of the subject must have its laboratory; no course complete without one!

Few of us stop to think that laboratory instruction is itself an experiment, or whether we are combining it with lectures and recitations in the right proportion to give the desired results; or indeed what are these desired results. In isolated instances we see the matter treated as one about which question may be raised. But in many others we may suspect the subconscious reasoning of a rapidly developing era that if a little of a thing is good, increasing amounts must be much better.

To Lomonossoff, it seems, goes the distinction of having built the first chemical laboratory (1748) for instruction and research. It would be enlightening if we could determine exactly his reasons for this departure. Yet the circumstances which motivated him in that day are quite different from those of the present and it is more than likely that were that innovator

to see it today he would not look with entire favor upon the development of his method.

The probability is that Lomonossoff introduced laboratory methods of instruction in order to train chemists and prospective chemists in the science of his day and the methods and manipulations whereby it could be advanced. If so, compared to apprenticeship, it savored of the efficiency of our own times. A method for training chemists! But of the multitude before whom the average teacher of chemistry today casts his erudite pearls—premedics, predentists, preëngineers of many types, students desiring culture, students needing a "laboratory unit," *et al.;* of this multitude there is but a handful of future chemists.

The laboratory of Lomonossoff was but the beginning and our present institutions are more directly related to Liebig's laboratory in Giessen (about 1825) where, after preparing the more important gases, careful training was given in qualitative and quantitative analysis.

In this country, although the study of chemistry was developed early, it was treated as a part of physics and as such introduced into the colonial medical schools, and it was not until 1795 that Princeton instituted the first independent chair of chemistry. But as to the laboratory development of the science, we find an interesting statement in the direction to the board of trustees of our earliest scientific school of higher grade (1824):

"These (the students) are not to be taught by seeing experiments and hearing lectures according to *the usual method.* But they are to lecture and experiment by turn, under the immediate direction of a professor or competent assistant. Thus by a term of labor, like apprentices to a trade, they are to become operative chemists."

Though this[1] pointed the way to laboratory work by the student, it was not until the Morril land grant of 1862 that a widespread impetus toward the extensive development of scientific and agricultural schools paved the way for laboratory methods to take firm hold in our educational system. It was about this time that the influence of the laboratory at Giessen began to be felt in this country.

Thus the extensive application of laboratory methods to the teaching of chemistry is of relatively recent origin. Coincident with this change the status of the subject altered. While chemistry was originally smuggled into the educational system under the wing of medicine, it developed an importance of its own such that now it is no longer being fostered by medicine, but the medical schools are making ever-increasing demands upon the separately established departments of chemistry. Though chemistry and medicine have thus ever been closely allied, the application of the laboratory methods to the teaching of chemistry took place independently

[1] In practice, however, this took the form of lecture demonstrations by the different students.

and to meet its own ends. As the science developed into a subject worthy of study in itself, we see a simultaneous change in the purpose of its teaching from that of training future chemists and, in its elementary aspects, a limited number of premedics, to that of giving a necessary and sufficient amount of its material to specialists in many allied fields and indeed that of giving the general student the benefits with which we have endowed such training. Yet though the primary purpose of the teaching has become somewhat overweighted with secondary objects, we have inherited, through the rapid succession of educational generations, an unquestioning belief that the laboratory method is sound and efficacious for all these many purposes. Though, in the institutions of higher learning, the proportion of embryonic chemists has become vanishingly small compared to the number of those to whom the subject is but a handmaiden to another profession or to whom it is but a science unit toward the certificate of culture, we have for the most part tacitly assumed that the needs of all who elect the subject are met equally well by the same method.

While this stress on laboratory instruction has been progressing, two outstanding developments have taken place. One is the problem which we have just mentioned—the rapid outnumbering of those for whom the subject is itself the aim. The other may possibly be an aid to the solution of the problem. This is the development within the university of another branch of learning—the science of pedagogy, whose exponents, as one of their number states, have been looked upon by certain of their colleagues as somewhat less than men and whose subject has not even been adjudged worthy of Christian charity. The fast-growing schools of education, in their better and more advanced forms, are attempting to study the aims and methods of all branches of teaching and by applications of educational psychology to test their soundness and efficiency. Such study has started at the bottom and is slowly working upward. From the kindergarten and the grade schools the ramifications of these workers are reaching the secondary schools, and in time may have an increasing influence upon the methods of their co-workers in the institutions of higher learning.

Up to the present, as new subjects have been introduced into the curriculum, the specialists in these fields have themselves attempted to define the needs of the students in these branches and to work out the principles by which these could best be satisfied. The result has often been a somewhat poorly thought out and unbalanced group of courses, since each leader, either through sincerity of belief in the importance of his subject, or a desire for a spot in the sun for his little sphere, has pushed his subject to the limit of his vocal chords or of his political intrigues.

That there is but little coöperation in the development of courses is frequently seen. When the question was raised by a professor of English, if, due to the many difficulties involved in the laboratory method, it could

not be dispensed with or at least limited for those not specializing in a certain science or allied fields, the terse reply by the professor of that particular science that he would give up laboratory when the department of English discontinued the writing of themes, received the plaudits of his fellow scientists. And what did the professor of education contribute? As is so frequently the case in the councils of the learned, while others spoke freely upon subjects in which they were not authorities, he bided his time thinking of the many experiments and the wealth of controversial papers which had been written, and he opened not his mouth.

For we do not find unanimity of opinion among the educators upon the matter of laboratory instruction. However, we do not need to go beyond our own experience to see that the writing of themes in English and the performing of experiments in science are not wholly analogous, since, except for a few in each branch, not many will conduct scientific experiments subsequent to their graduation while nearly all may find it necessary to compose an occasional letter and some, indeed, in spite of the ennobling teachings of the baseness of material wealth, may be called upon to write a check or even a will.

Few would suggest the lessening of laboratory work for prechemists except perhaps where historical methods have persisted far beyond their usefulness in pedagogy, science, or industry. For all types of students, such experiments as the Victor Meyer molecular weight determination might well give place to others of more theoretical or manipulative value, and many of the routine analyses, both qualitative and quantitative, might be replaced in view of the special methods which accuracy and speed have found it necessary to work out. For prechemists, as well as those not intent upon specializing in chemistry, many of the antiquated methods of preparation frequently found in our elementary courses, which in practice have been done away with by electrical methods, could surely be modified or omitted with profit.

But to return to the more general aspects of the subject with especial thought upon this latter group of students. Educators speak in no uncertain terms relative to a phase of scientific teaching which has very largely dominated laboratory work. "No better occupation for filling the void of eternity can be conceived than that of setting the pupils to 'rediscover' the procedures and truths which have been laboriously accumulated by the best minds of each generation. In the first place, they can never do it; and, in the second place, if they could, it would be an enormously wasteful process of learning.....Laboratory work, under this 'heuristic system' is extremely time consuming."[2]

It is but a poor compliment to the reputed integrity of the scientist if he feels himself called upon to require the student to verify each law, the

[2] Chapman and Counts, "Principles of Education," Houghton Mifflin Co., 1924, p. 560.

solubility of each compound and the color of each precipitate. Surely the teacher of history would find it a difficult task if he felt it necessary, in addition to giving lectures upon the events of the past and the development of institutions, to place before the student the original sources from which he might reconstruct the material of the lecture, and in this way prove to his auditors that he had come not unto them with cunningly devised fables. True, source work in history is being introduced into many such courses, but rather to teach the student the methods by which history has been compiled than to cause each successive generation of students to attempt to rebuild the master works of great historians as a pedagogical procedure. Nor is this method introduced with the tacit assumption that all who take a single course or even a minor in the subject are to be contributors to the field. Several hours of source work per week for all students taking one or two courses in history might be as justifiable as laboratory work for all students taking introductory courses in chemistry.

The thought may have occurred that chemistry is reproducible while history, although it repeats itself, we are told, cannot be re-enacted in the same sense as can chemical events. Incidentally, were this possible, the historian would be faced, perhaps, with the same difficulty as the chemist as to what particular portion of the past should be reproduced under the title of a first-year course. Surely we cannot claim to have completely met the problem of giving an adequate introductory survey of the field of chemistry by means of the usual first-year course which makes a study of a limited number of substances, with emphasis upon the relatively few non-metallic elements, of a group of what we have come to look upon as the more important compounds, and of certain of the better established generalizations. However, the problem in both cases is the same—that of best meeting the needs of the various types of students. If this consists in giving a certain basic knowledge of the subject-matter, an insight into its accumulation, and a consciousness of whatever benefits these may be, it is obvious that it cannot be achieved by the same method. The fact that the phenomena of chemistry are reproducible offers an excellent opportunity to furnish the student with insight into the manner in which the subject has reached its present state. This does not in itself, however, justify the laboratory method as a means of teaching the subject-matter, nor its over-working until the experimental basis of the subject is lost sight of. More than the availableness of a method is necessary to prove its value and adequacy. Comparison of the methods of teaching various subjects—chemistry, English, history, Latin—is always dangerous when carried to the extreme, since for each not only the aims but the means whereby these aims may best be attained are different. To define and select these requires freedom from prejudice and a wider experience than is usually possessed by the specialist in a given field.

As one of the special benefits of science instruction, we have endowed laboratory training with certain general results which experience and modern educational psychology do not always bear out. Quantitative experiments especially, we are told, "give the pupil a confidence in the exactness of the experimental basis on which the science rests." This aim is not always attained if we may judge by the remark of an unusually brilliant, professional man when he said, in substance, relative to his one year of chemistry that it is always a marvel that the science has achieved so much being based upon hypothesis and theory and with so little being known. The training itself is said to give certain qualities such as the ability to observe accurately, to draw correct conclusions, to produce open-mindedness, and the like, which shall be of value to the student not only within the course but in after years. Yet an eminent chemist used to be fond of telling how for at least twenty years the color of a certain compound had been reported to him by successive students to be that which he had mistakenly believed it to be until at last one student who had, perhaps previous to his entering college, acquired the ability to observe accurately, to draw correct conclusions, and to be open-minded, pointed out to him his misconception. Let us hope that the standards of integrity which our qualitative and more especially quantitative experiments have so frequently fostered will not follow the student throughout life.[3]

Other advantages which we have quite freely claimed to accrue from scientific training, particularly that involving laboratory work, are not so readily subject to test by our own experiences. We have liked to think, for example, that the manipulative skill, attention, reasoning powers, "caution and mental rectitude," which the laboratory is supposed to engender, have "a broader significance beyond the operations and objects peculiar to chemical work." However, those who have made a study of the transfer of such abilities do not encourage us in this hope. Thus Thorndike says:

"The improvement of one ability may help or harm others.... In general, the improvement of any one of the abilities which are recognized as desirable helps any other.... The gain in the efficiency of other abilities from the improvement of one is, however, far less than has been expected." As an example of the belief which is still all too prevalent among teachers of science, he quotes, "By means of experimental and observational work in science.... his attention will be excited, the power of observation.... much strengthened, and the senses exercised and disciplined." Thorndike concludes his discussion: "As a result of the experiments that have been made since 1900, such expectations of universal transfer of ability in large amounts are no longer entertained by competent thinkers.... It is agreed that a gain in one ability improves others only in so far as it is proved to

[3] Stone, THIS JOURNAL, **4**, 620–5 (May, 1927).

do so—that the question of the disciplinary value of any training is a question of fact to be measured, not an article of educational faith to be assumed. It is agreed that, roughly, we can hope for such wider improvement only in so far as the other abilities in question are in part identical with the ability specially trained."[4]

As has already been mentioned, experiments and changes in the educational system seem to start at the lower levels and work upward. Numerous educators have questioned the laboratory method of teaching science in high school and recently a number of experiments intent upon determining the relative merits of the laboratory and the lecture-demonstration methods have been carried out. After reviewing reports of eight investigations relative to the teaching of science in high school, Downing comes to the conclusion that "The lecture-demonstration method of instruction yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense."[5] Cooprider estimates the saving in time to be about 50 per cent and Anibal, another investigator upon whose work the report is based, estimates that to teach chemistry to a class of thirty pupils by the lecture-demonstration method costs about 7 per cent as much as by the laboratory method. The saving in time might well be used to give the student the concept that the subject is one which is ever growing beyond the historical stage of any written textbook. This view might be further developed by turning the saving in expense, in the higher institutions, toward research by the faculty members. The permeation of the research spirit throughout the department would perhaps do more to place in the minds of the students the idea that the subject rests upon an experimental basis and that it is an ever-growing branch of learning than do the present-day laboratory methods. That this would raise the standards and achievements of those in the teaching profession is obvious.

In addition to being superior for imparting knowledge, which is, of course, but one phase of the subject, other investigations summarized by Downing point to the conclusion that "The lecture-demonstration method appears to be the better method for imparting skill in laboratory technic in its initial stages and for developing ability to solve new problems." A modified system of demonstration in which the pupil participates seems to be unusually successful in high-school teaching.[6] It is not unlikely that the results of such experiments will indicate in time that the college and university courses in chemistry, at least those designed for students not specializing in the subject, might well be modified to include less or no laboratory work to the benefit of all concerned.

[4] Thorndike, "Education," The MacMillan Co., **1923,** pp. 112–6.

[5] *Sch. Rev.*, **33,** 688–9 (1925).

[6] Smith, THIS JOURNAL, **2,** 231–4 (April, 1925); **3,** 307–12 (March, 1926).

If the laboratory is to be continued and made an efficient method of instruction, we, as scientists, should pay close attention to the opinions and findings of those who are attempting to place education itself upon a more scientific basis. After discussing the objectives and the advantages of the proper use of experimental methods in teaching, Thorndike adds: "Like any reform in education, the laboratory method has suffered at the hands of its friends, by being used indiscriminately and by being over-used. It is not scientific to spend two hours learning by the manipulation of instruments something which could be better learned in two minutes by thought. . . . Nor is it safe to disregard *what* is taught, so long as it is taught as an exercise in scientific method. A laboratory should teach facts important in themselves."[7]

In conclusion, then, let us recall that the laboratory method of instruction, in its present form, is a somewhat new development. Seemingly it is but little questioned by those who most use it and their views are colored, for the most part, by their personal experiences in specialization. During the development of this method of teaching a large influx of students not majoring in chemistry has taken place.[8] Simultaneous with these changes, scientific studies in education have devised ways of determining the efficiency of some of the methods which we have come to look upon as established. They have weighed the laboratory method in the balance and found it wanting—at least not possessing all the advantages that we have been prone to ascribe to it. An application of these findings may help us to solve the problem of the large number of students other than prechemists who are now pouring through our laboratories. The indications from such investigations as have been made are that the suggested modifications will be a benefit not only to the student but also to the teaching staff and the institution.

Let it not be supposed that the suggestion is here made that the teacher of chemistry should have no ideas upon chemical education nor express any views upon the teaching of his subject. Indeed, he is perhaps the one best qualified to discuss the training of chemists. Further, his suggestions should be valued and given weight upon the details of the teaching of those not primarily interested in chemistry. But for the broad policies involved in teaching this latter group, what should be the aims of the course, by what methods they could best be attained, for these and a host of similar questions it would seem that the best policy could be worked out in conjunction with those specialists who see as a whole the educational aims of the different types of students and chemistry in its proper perspective.

To put into effect radical changes, no matter what their proven educational advantage might be, any individual or institution would, at present,

[7] *Loc. cit.*, p. 178.

[8] Haynes, *Science*, **65**, 462–5 (1927).

be practically powerless, since if applied to high-school students there would be the difficulty of the required laboratory hours for college entrance and if applied to certain types of college students there would be the problem of transfer to different institutions and the required units for entrance to medical schools. However, with a more general knowledge of these developments among teachers of chemistry as individuals, there may in time be a modification of the requirements which chemists themselves have helped to build up.

Vacuum Tube Tests Wave-Length Crystals. The path traced by a moving spot of light in a special vacuum tube reveals the quality of a quartz crystal to be used in keeping broadcasting stations on a constant wave-length. At the meeting of the American Physical Society, Dr. Karl S. Van Dyke, of Wesleyan University at Middletown, Conn., told of his researches which may play a useful part in the production of these important crystals.

These piezo-electric crystals, as they are called, usually consist of plates of quartz, cut from larger quartz crystals. At present, it is usually necessary to try several of them in order to find a satisfactory one, as a large number may not work at all. Some may be considerably improved with a little grinding.

With the use of the cathode-ray oscillograph, as the special vacuum tube is called, a stream of electrons, or cathode rays, falls on a screen where it makes a spot of light. The motion of the stream of electrons causes the spot to trace a curve, and quick inspection of this curve reveals the quality of the crystal.—*Science Service*

Insulin Affects Fish As It Does Humans. Insulin injected into the blood streams of various kinds of fish has demonstrated that even with these humble scaly creatures we are brothers under the skin. For fish blood has its sugar radically reduced by the diabetes-curing drug, and if only the normal concentration of sugar is present the poor fish goes into convulsions, just as a man or a warm-blooded animal would, and may die as a result, unless a counteracting dose of glucose is injected after the insulin.

These results of researches on the blood-sugar physiology of fishes were reported before a session of the American Association for the Advancement of Science by Dr. Irving E. Gray of Tulane University.

Only one species of fish, the puffer, resisted the action of the insulin and did not go into convulsions, Dr. Gray reported. This fish normally has a very low concentration of sugar in its blood.—*Science Service*

Must Eat Greens to Get Vitamins. Vitamin A, the substance needed for normal growth and health, is present in green vegetables, but the much-sought-after blanched garden products do not have it. This has been proved to be true in the case of asparagus, at least by Dr. John W. Crist and Dr. Marie Dye of Michigan State College, who reported their experiments before a session of the American Association for the Advancement of Science, which held its annual meeting at Nashville, Tennessee, the week after Christmas.

Young white rats were fed on a diet lacking in the growth-promoting vitamin. Some of them were given, as a supplementary ration, a small amount of green asparagus tips every day, while a second lot of rats, as "controls" were fed on blanched tips. The asparagus was fed both fresh and cooked. In all cases the animals receiving the green asparagus grew and thrived normally, while the ones on the blanched tip diet dwindled and died. Even doubling the amount of blanched asparagus fed to one of the rat groups failed to save them.—*Science Service*

DR. ROBERT PETER

J. S. MCHARGUE, UNIVERSITY OF KENTUCKY, LEXINGTON, KENTUCKY

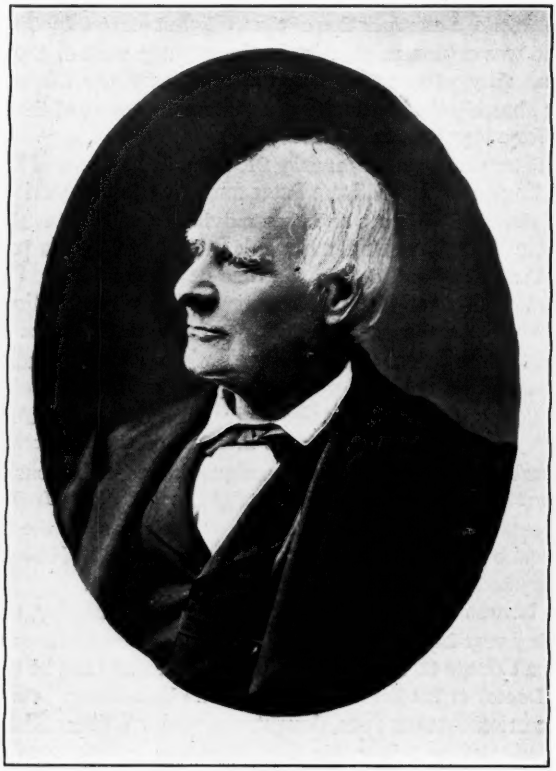
The name "Peter" has been continuously associated with chemistry in Kentucky through the labors of Dr. Robert Peter and his son, Dr. Alfred Meredith Peter, for almost one hundred years. The work of the son has been in a measure a continuation of the work first started by his illustrious father, who was a pioneer chemist in the country west of the Alleghany Mountains. Any attempt to describe separately the labors of either is to break abruptly the continuity of an interesting story of the progress in chemistry for a long time in Kentucky.

Robert Peter was born on January 21, 1805, in the town of Launceston, Cornwall, England. In 1817 the Peter family came to America, stopping for a brief time in Baltimore and then moving on to Pittsburgh, Pennsylvania, where Robert, when a mere lad, was placed by his parents in a wholesale drug store and during the time of his employment acquired a passion for chemistry which filled his thought and gave direction to his life in later years. At the age of twenty-three he entered the Rensselaer Institute Scientific School at Troy, New York, and after spending one session there acquired the title of Lecturer on the Natural Sciences. In the latter part of the same year he delivered a course of public lectures on chemistry in Pittsburgh and, as a member of the Hesperian Society, made a number of scientific, literary, and poetical contributions to the *Hesperus*, a periodical published at Pittsburgh, in 1828–29. In 1829 he delivered a course of lectures on the natural sciences to the Pittsburgh Philosophical Society, of which he was a member, and in 1830–31 lectured on chemistry in the Western University of Pennsylvania.

In 1832 he was induced to come to Lexington, Kentucky, and early in the following year he was unanimously elected to the Chair of Chemistry in Morrison College of Transylvania University. In 1834 he received the degree of Doctor of Medicine at Transylvania University. On October 6, 1835, he married Frances Paca, daughter of Major William Smith Dallam, of Maryland, and to this couple five daughters and six sons were born, Alfred being next to the youngest child.

In 1847 Dr. Peter was chosen Dean of the Medical College and served in this capacity until the College was closed in 1857. He also served as librarian of the University and in 1839 he and Doctor James M. Bush were sent to London and Paris to purchase books, apparatus, and other means of instruction for the medical department of Transylvania University. Of the books, apparatus, etc., purchased in Europe by Doctor Peter and Dr. Bush, there is a record of the following account having been rendered on March 25, 1839: Books and plates, six thousand dollars; chemical apparatus, two thousand five hundred dollars; preparations

for anatomy and surgery, one thousand five hundred dollars; models for obstetrics, five hundred dollars; specimens for materia medica and therapeutics and drawing, five hundred dollars. A total of eleven thousand dollars, which for the time was no mean pecuniary expenditure. Referring to this purchase in a lecture to the Medical Department in 1854,



DR. ROBERT PETER

Dr. Peter says, "A very large addition was made to the library, museum and apparatus by extensive purchases in Europe (selected by Dr. Bush and myself) bringing the former collection up to 8000 volumes and making the latter equal, if not superior, to any in the United States." While on this trip to Europe he wrote from Paris to his wife (June 27, 1839), after hearing numerous lectures by famous doctors and after visiting the model hospitals of the day, "We can have as great men (in Lexington) as either

of these cities (London and Paris), and neither of them contains a man as eminent in surgery as Doctor Dudley;" and from London, August 11, 1839, he wrote again to his wife: "We have bought a great many fine books and a great deal of excellent apparatus and anatomical and other models. Transylvania will shine. No other institution in our part of the world will be able to compare with her in the means of instruction. In fact, I have seen none in Europe that is more completely prepared to teach modern medicine."

Daguerre, in 1839, had just published the process of his wonderful art of photography and it constituted perhaps the greatest novelty in Paris at the time of the sojourn there of Doctors Peter and Bush, so a daguerreotype outfit was included in the apparatus purchased for Transylvania University and it is still preserved, among other apparatus and books purchased on this trip, in the museum and library at Transylvania College.

On his return from Europe Dr. Peter engaged in much valuable chemical research in medicine, notably his analyses of urinary calculi, which were published in Volume 5 of the *Western Lancet*, in 1846. In the same year he experimented with the then newly discovered explosive, guncotton, and with pyroxylin made from paper and other materials. In the early part of his scientific career he experimented much with electricity, then little understood. Dr. Mitchell, writing in his historical catalogue, in 1838, says: "Dr. Peter added to the chemical department several powerful galvanic batteries and a fine collection of apparatus recently procured from the East, making the laboratory more complete than it ever has been before." He also gave much attention to geology, mineralogy, zoölogy, and botany. Associated with Doctor Charles W. Short and Professor Henry A. Griswold, he made important botanical explorations and collected a fine herbarium, including specimens exchanged with leading European botanists. He presented his herbarium, in later years, to the Kentucky State Agricultural and Mechanical College and it has been preserved by the department of botany and is outstanding because it contains a greater number of species of the flora of this region than any collection that has been made at a later time.

Doctor Lewis Rogers, in his address as President of the Kentucky State Medical Society, in 1878, says: "In the interesting departments of Botany and Chemistry at Transylvania University, Doctor Charles Wilkins Short and Doctor Robert Peter are known throughout the scientific world. As teachers, the modest, almost shrinking manner, the seemingly acerb dignity and Addisonian style of the one and the lucid expositions and brilliant illustrations of the other, must be remembered by all who ever listened to them."

Dr. Peter was one of the founders of the Kentucky School of Medicine

at Louisville. He lectured there during the winter sessions, 1850–1853, the first years of its existence, filling with distinction the Chair of Chemistry.

On October 19, 1853, at the third meeting of the Kentucky Medical Society, at Lexington, Dr. Peter proposed to memorialize the Kentucky Legislature in regard to the establishment of a Geological Survey of Kentucky. Accordingly, he prepared such a memorial (in connection with his "Report on the Relation of Forms of Disease to the Geological Formation of a Region") accompanied by a geological map colored by himself. In consequence of this memorial which was unanimously sanctioned by the several agricultural societies of the state, the first Geological Survey of Kentucky, which was also the first large State enterprise of the kind undertaken west of the Alleghanies, was begun in 1854, with Dr. David Dale Owen as the director and Dr. Robert Peter as chemist. While chemist to the Survey, Dr. Peter demonstrated what he had previously maintained and ably argued, that by soil analysis could be determined the elements necessary to increase and preserve the fertility of soils. He was probably the first in America to apply quantitative and qualitative methods of analysis in this manner. Certainly the first to apply them to any great extent. He proved by numerous results that chemical analysis, as practiced by him, was capable of showing the deterioration of soils by long cultivation. He did this by comparing the composition of the virgin soil with that of soil taken from a near-by old field. It must be understood that this work was done long before Experiment Stations were established and before the biological methods of studying the soil were developed. Notwithstanding, the newer methods of studying the soil, it may be said and without fear of serious contradiction that chemical analysis will continue to be one of the most important means of studying soils.

The number of chemical analyses accomplished by Dr. Peter for the Kentucky Geological Survey seems well-nigh impossible when it is considered that at the same time he lectured daily six times a week in two colleges, never omitting to prepare experiments in illustration of his subject. Some eastern chemists were actually disposed to dispute the facts. One of these asserted that "No chemist could make more than one soil analysis in less than a month." Doctor Owen's reply to this statement was: "Without a knowledge of the peculiar circumstances under which the work was performed, the amount of Dr. Peter's chemical labor during the last six years, as chemical assistant to the Kentucky Geological Survey, might appear incredible, for he has in fact performed a greater number of reliable, detailed, practically useful analyses of soils than any living chemist." Dr. Owen adds, in further confirmation of the prodigious output of Dr. Peter's results, a description of the laboratory in which the work was done. He says: "The principal operating room in which Dr. Peter

made his analyses is 15 feet square, the working and balance tables stand within three feet of each other, and the furnace, sand, and water baths three feet from the former, so that one or two steps suffice to reach all important parts of the different operations in their various stages of progression. The reagents constantly in use were contained in a case which rested on the working table within an arm's reach of the operator, and his recording desk in a drawer of the same table." Dr. Owen, zealous to defend Dr. Peter, explains further that the latter was aided by a more than common physical as well as mental aptitude. Dr. Peter took no part in this defense save to extend to the skeptics an invitation to visit his laboratory and examine his manner of working.

The death of Dr. Owen, the director, in 1860, and the approach of the Civil War terminated for a time the activities of the Kentucky Geological Survey. During the six years of progress of the Survey Dr. Peter had made one thousand, one hundred and twenty-six quantitative chemical analyses, three hundred and seventy-five of which were of soils, in each of which, on the average, twelve different constituents were determined and, in addition to this and the preparation of his own chemical reports, he had personally supervised the publication of the four royal octavo volumes of this Survey, reading and correcting all proof and adding an obituary, biographical sketch of his friend, the late Doctor Owen. With the outbreak of hostilities in 1861, Doctor Peter was made Acting Assistant Surgeon in charge of Military Hospitals at Lexington, Kentucky, being most of the time senior surgeon in charge. After the close of the Civil War the activities of the Kentucky Geological Survey were resumed under the direction of Professor N. S. Shaler with Dr. Peter as chemist. During the five years, 1873–78, Doctor Peter prepared three chemical reports of his analytical work, which contained a total of four hundred and seventy-seven pages describing eight hundred and seventy-one analyses.

In the Geological Survey continued under the direction of Mr. John R. Procter, from 1878 to 1891, Dr. Peter prepared six reports, five of which were published. These contained five hundred and eighty-eight pages and described nine hundred and seventy-seven analyses. The sixth report which was not published at the time because of the lack of funds, contained about four hundred analyses. Thus, for the new survey, Dr. Peter had made about two thousand, two hundred and fifty analyses. In addition to this he contributed to a Geological Reconnaissance of the Southern and Middle Counties of Arkansas, which was made during the years 1859–60, an octavo volume of four hundred and thirty-three pages, the chemical report in which he described the history and reported the analyses made by himself of two hundred and seventy-one samples of soils, subsoils, under-clays, nitre-earths, etc., of Arkansas. During the same time he made for Dr. D. D. Owen, director of the State Geological Survey of Indiana, chemical anal-

yses of thirty-three soils, subsoils, etc., which were published in the reports of that survey.

As early as 1849, Dr. Peter called attention to the fact that the lower Silurian limestones always contain a notable quantity of phosphate, and that this circumstance in part accounts for the richness of the bluegrass soils of central Kentucky.

In 1865, according to the educational plans of President John B. Bowman, Kentucky University was removed to Lexington and united with Transylvania University and the State Agricultural and Mechanical College was organized as a College of Kentucky University. Doctor Peter occupied the Chair of Chemistry and Experimental Philosophy in the newly organized university, having declined the Presidency of the Agricultural and Mechanical College, which was offered to him by Regent Bowman. At this period he devoted his every energy of mind and body to assist in the upbuilding of what he fondly hoped would be the great educational institution of the middle West and South: for the training especially of Kentucky's youth of every rank and creed and for the benefit of all men of all nations who sought knowledge. He accepted and accomplished, it is said at the time, the work of three average men. On the separation of the State College from the Kentucky University in 1878, he remained at the head of the department of chemistry of the State College, which position he retained until 1887 when he was made emeritus professor of chemistry in the State College, after having attained the age of eighty-two, and given fifty years of active service to the science of chemistry in Kentucky.

During the remaining seven years of his life he retained his activity of mind and body and his cheerfulness of spirit up to a very short time before his death which occurred in the eighty-ninth year of his age, April 26, 1894, at Winton, his home in the country, eight miles north of Lexington. He had, as it is said he often wished, "Worn out rather than rusted out." A colleague of more than twenty years thus summarized his life and character: "Intense devotion to physical science and work of the laboratory, purity of speech and modesty of manner, fidelity to settled convictions and principles; above all, his long and illustrious career in educating so many thousands of the young, and in setting before them a model so worthy of their imitation and remembrance; these were the traits, this was the service that crowned his busy life of nearly ninety years with honor, admiration and renown."

The foregoing biographical sketch is composed, for the most part, of excerpts from the "History of the Medical Department of Transylvania University," which forms No. 20 of the Filson Club Publications, Louisville, Ky., 1905.

POSTERS IN CHEMISTRY

FANNIE L. BELL, RIDGEWOOD HIGH SCHOOL, RIDGEWOOD, NEW JERSEY

In connection with an exhibit[1] held by the Chemistry Department of Ridgewood High School, Ridgewood, New Jersey, a series of posters which aimed to show the relation of chemistry to everyday life was displayed. These were made by pupils in the general chemistry class, or the class that was not preparing for College Board Examinations, and several laboratory periods were used for the work. The posters were made on heavy gray cardboard, twenty-six by thirty-eight inches. For the lettering we used Wilson's gummed letters (sizes 4 and 7) purchased from the Tablet and Ticket Company of 35 West 45th Street, New York City. While there was an expense of about fifteen dollars for this item, the amount of work was thereby reduced to a minimum.

Titles for the proposed posters were listed on the bulletin board and each pupil was asked to select the one he wished to work on. In some cases two pupils worked together. They were asked to collect any pictures or other material that would illustrate their titles and were given any material which had been already collected. As the whole list was posted all the pupils were on the lookout for material that might be of use to anyone in the class.

Since the alchemist is one of the first subjects mentioned in our textbook we illustrated this by a poster bearing the words "The Alchemist Preserved Chemistry through the Middle Ages Using These Elements Only." Around the margin were placed the symbols and names of the elements known to the alchemists. These were obtained from "The Alchemistic Symbols in Research Narratives," Vol. I, published by Williams and Wilkins Company. A picture of an alchemist at work was added with the words: "He sought:—The Philosopher's Stone, The Elixir of Youth, To Change the Baser Metals into Gold or the Transmutation of Metals."

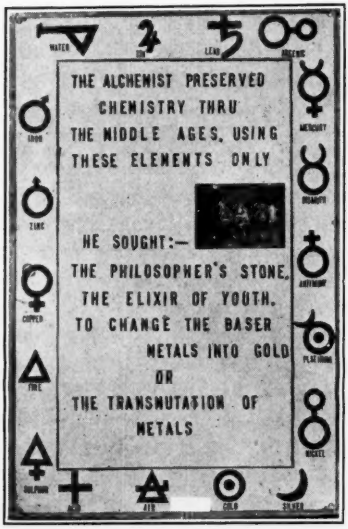
Following this was another poster which read: "The Modern Chemist Has Fulfilled the Dreams of the Ancient Alchemist." This was illustrated by pictures of modern research and school laboratories in contrast to the secret caves and crude methods of the alchemists. It also contained accounts taken from the *Science News Letter* and *Popular Science* of the claims of certain chemists that they had really changed mercury into gold.

Since these experiments have not stood the test of further research I would not suggest using the same material, but there are many ways in which the marvels of modern science parallel the aspirations of the ancient alchemist. For instance, one sees the effort to produce the royal purple

[1] An article in the March number of THIS JOURNAL will describe the exhibit mentioned.

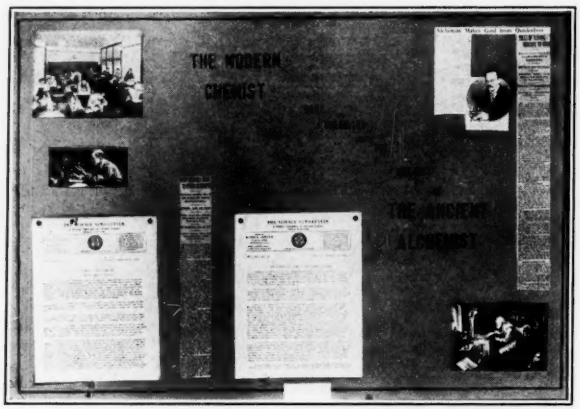
of the Middle Ages in our modern coal tar dyes, or the finding of the "elixirs of life" in modern medicine.

Much material can be found to prove that "Chemical Terms Are Used in Modern Advertisements." I placed a small arrow beside each chemical term such as acid, neutralization, alkaline, protein, vitamin.

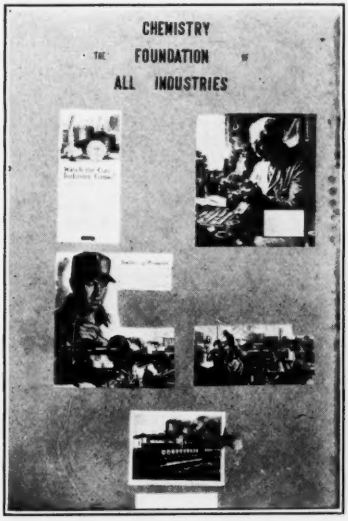

THE ALCHEMIST PRESERVED CHEMISTRY THRU THE MIDDLE AGES, USING THESE ELEMENTS ONLY
HE SOUGHT:—
THE PHILOSOPHER'S STONE,
THE ELIXIR OF YOUTH,
TO CHANGE THE BASER METALS INTO GOLD
OR
THE TRANSMUTATION OF METALS

"Chemistry Is the Foundation of All Industry" was illustrated by a composite picture taken from a General Motors advertisement, showing in the foreground glimpses of many modern industries and in the back-ground chimneys of blast furnaces, etc. Gas manufacturing and petroleum refining plants are also shown.

"Chemistry Eliminates Waste" was the title to display a series of advertisements along this line which were collected from *Chemical & Metallurgical Engineering* and the *Saturday Evening Post*. The Timken Roller Bearing Company furnished very attractive and striking material for a poster showing how chemistry makes valuable products out of formerly wasted materials. Further illustrations are to be found in the prevention of corrosion of metals by our modern stainless steels, or in the



numerous products obtained from coal tar which was formerly only a sticky, black waste, hard to dispose of, or by the potash which was obtained during the war by use of the Cottrell dust precipitation methods in cement industries. Another idea along the same line suggested the poster entitled "How Science Controls the Smoke Menace," showing diagrams of a smokeless stoker and pictures of a plant before and after installation. The best diagram that I have found to show how this device operates is given on page 309 in Gray, Sandifur, and Hanna's "Fundamentals of Chemistry." These were supplemented by some advertising material showing how the same result could be obtained by the installation of a certain mechanism in an ordinary furnace. Dia-



grams showing the construction of the Cottrell precipitator with a "before and after" picture completed the story. I used the word science instead of chemistry on this poster in deference to the principles of physics involved in the latter process.

"Contributions of Chemistry to the Automobile," of course, finds a fertile field in advertisements of tires, batteries, special steels and alloys, finishes, oils, and gasoline.

"Contributions of Chemistry in Aviation" is somewhat similar. One will find inspiration and ideas by reading the chapter on Aviation in Vol. I of "Chemistry in Industry." *Popular Science* and the *Scientific American* furnish much illustrative material for posters of this sort.

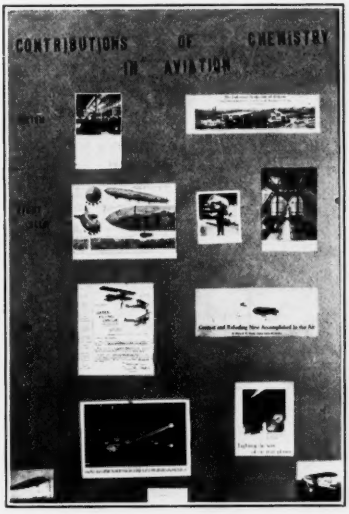
"Chemistry Produces Our Light," contained an advertisement of the Edison Mazda Lamps showing the dipping of the old tallow candle and a series of cuts showing the development of the present electric bulb. The subject might be worked out in a number of other ways to show the steps in the progress of methods of lighting—from the spark struck by flint, through the burning fagot, the candle, the oil and gas light, the Welsbach burner, to the present perfection of the Mazda.

On the other hand, "Chemistry Fights Fires" is a poster which is valuable for class-room use, as I showed by means of diagrams the construction and operation of the common commercial fire-extinguishers—Pyrene, soda-acid, anti-freeze solution, and Firefoam. The Pyrene Manufacturing Company of Newark, New Jersey,

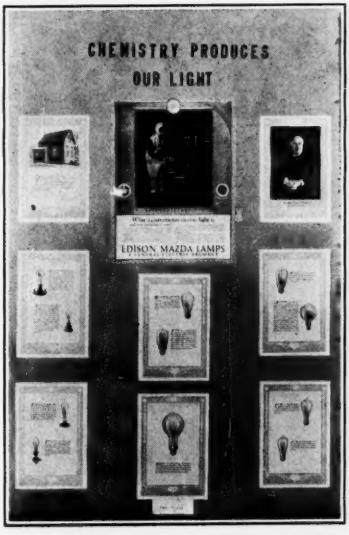
sent me much good illustrative material including a chart giving a comparison of the four types as to the chemical reactions, methods of use, limitations, etc.

Much material, such as Tanglefoot spray, rat poisons, and insecticides, can be found to show that "Chemistry Rids Us of Pests."

"Chemistry in Our Pleasures" can be illustrated by a wealth of material advertising movies, radios, victrolas, candies, Tarvia for good roads, etc. A poster of this kind may be used early in the year as a means of spurring the pupils on to find out the chemical principles employed in the manufacture of these products, or it can be used at the end of the year as a means of review.



"Chemistry Means Comfort and Convenience in the Home" was illustrated by material advertising Pyrex baking dishes, Sterno canned heat, radium-lighted clocks, electric refrigerators, improved gas burners, flash-



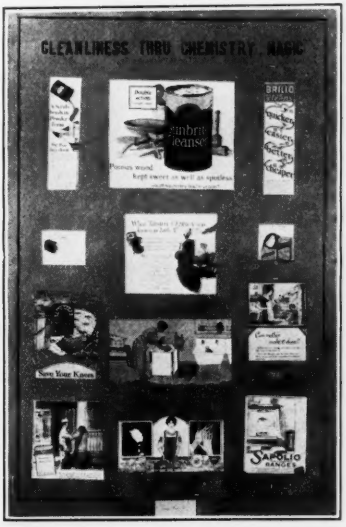
lights, and a very good picture showing the casting of the heating unit of an electric iron.

"Cleanliness thru Chemistry Magic" showed Drano for the lazy drain, Sunbrite Cleanser for wooden dishes, Brillo for aluminum, and a most interesting advertisement of Lux telling how Edison, when a lad, accidentally spattered mud on a valuable old shawl and how sixty years afterward it was restored to its original beauty and brightness by the use of Lux. Others showed Old Dutch Cleanser for the laundry tubs, Ivory soap for cleaning outside woodwork, Sapolio for cleaning kitchen ranges, Lux to save your hands when washing dishes and Gold Dust to "save your knees" in cleaning

floors, together with P and G Naphtha for the laundry and Fels Naptha for removing stains. Thus the whole household, both outside and inside, is kept spotless—all due to the magic of chemistry!

"Chemistry Protects Our Health by Antiseptics and Disinfectants" suggests the numerous advertisements which fill our magazines, such as those of Lysol, Listerine, Zonite, Unguentine, and tooth powders of all kinds, together with Scott Tissue towels and first-aid materials.

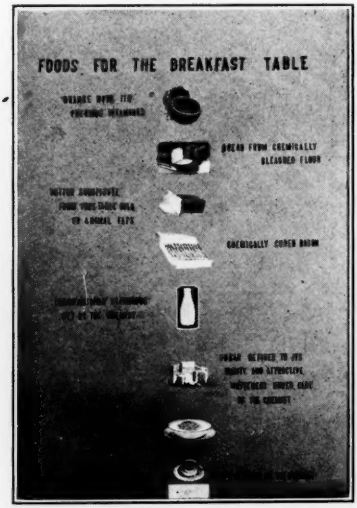
"How Chemistry Protects Our Water Supply" was told in picture with as little printed material as possible. The poster showed the use of a certain kind of pipe in "guarding the nation's water supply," cross sections



of the concrete dams, reservoirs, and conduits of the New York City water supply, the cylinders of chlorine used in the chlorination plant, and an ultra-violet ray apparatus, filter beds, an aëration plant, views of a water-testing laboratory and pictures of cultures from pure and impure water samples.

That "Chemistry Aids the Cook" was clearly shown by references to gas burners, Jello, Certo, Steero, Mazola, Wesson Oil, yeast, baking powder, and evaporated milk.

"Foods for the Breakfast Table" showed pictures of the various foods with an accompanying inscription for each: "Orange with its precious vitamins," "Bread from chemically bleached flour," "Butter substitutes from vegetable oils or animal fats," "Chemically cured bacon," "Cream and milk standards set by the chemist," "Sugar refined to its purity and attractive whiteness under care of the chemist," "Cereal with its calories measured by the chemist," "Coffee blended by the chemist." This might be worked out in other ways such as by having a picture of a table



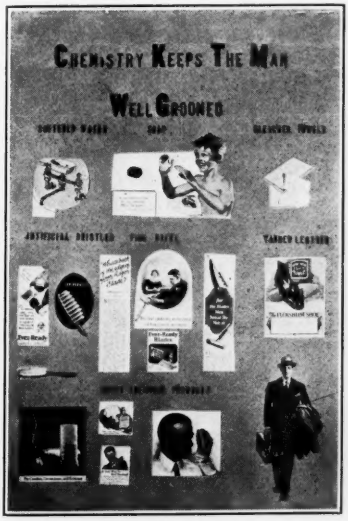
spread with the silver and food as the center of the poster, with lines leading to the inscriptions, very briefly telling the story of the chemist's work in the bleached linen, the silver, the china, the glassware, as well as the articles of food.

"Chemistry Keeps the Man Well Groomed" and "Milady's Toilette" showed softened water, bleached towels, synthetic perfumes, artificial bristles, razor blades, synthetic ivory, shaving creams, manicure supplies, and other materials which chemistry produces for toilet accessories both for the lady and gentleman.

"The Fashion Plate" showed a large fashion plate attached to the cardboard and at the sides statements which applied to this particular figure.

"American Made Dyes Are Now Fast Color" is something that we as chemistry teachers ought to preach to the American public. This can be easily illustrated by the brightly colored advertisements of many of our textiles and dyes.

A series that I found especially valuable in class-room work was on alloys. One poster stated that "An Alloy Is a Mixture of Metals." Small bottles filled with metals were attached to the cardboard by means of elastic cord and specimens of the resulting alloys followed the arrows leading from the bottles. On this chart we indicated plainly the metals used in making solder, bronze, brass, shot, dental filling, and sterling silver.



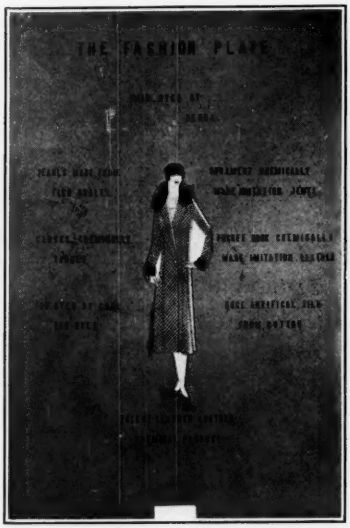
A chart showed the metals that, melted together, form Wood's metal and how this is used in the automatic sprinkler system.

Another poster showed the constituents of "Other Alloys" such as stainless steel, bell metal, monel metal, and some of our higher grades of steel together with illustrations of their uses.

Another showed the constituents of "Type Metal" with a pig of the same and through the courtesy of our local paper "Ridgewood High School" was added in different sizes of linotype and samples of foundry cast type.

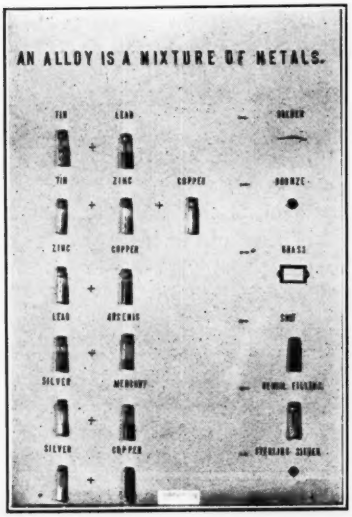
That "Agriculture Turns to the Chemist to Restore Its Exhausted Soils and to Reveal the Secrets of the Growth of Plant Life" was clearly shown by material obtained from various organizations producing fertilizers.

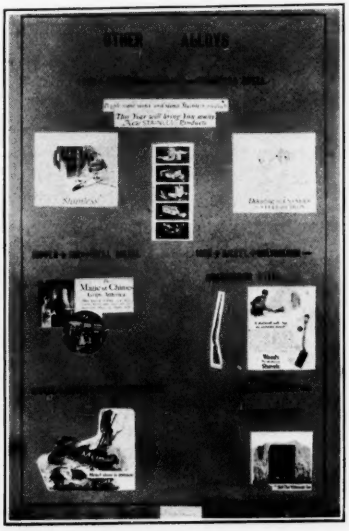
One poster bore the words "Opportunities in Chemistry." On it were



replies to a letter which I had written to a number of prominent technical schools asking what were the opportunities open today in the field of chemistry.

I believe there are a number of benefits to be derived from the activity





of a class in making posters of this sort. First, it impresses upon the pupil the tremendous rôle which chemistry plays in modern everyday life. Second, it shows the pupil that our magazines are filled with references to chemical processes, both in their articles and in their advertisements, and when once a pupil starts on a "hunt" for material he will be fascinated by it and will soon develop the habit of looking for scientific material in every paper and magazine which he reads. Third, the posters furnish good material for a chemistry exhibit to put before the public and thereby increase interest in the subject. Fourth, the pupils in the lower classes in the high school are stimulated to elect chemistry because they can see that it explains some of the problems about which they have been thinking. Fifth, it provides excellent teaching material which will accumulate from year to year.

Keeping Qualities of Butter Studied. Well-worked butter keeps the best. An investigation on the distribution of bacteria in butter reported to the Society of American Bacteriologists by Drs. Otto Rahn and H. H. Boysen, of Cornell University, recently, indicates that many of the bacteria found in butter occur in the droplets of moisture that it contains. Consequently, the smaller the droplets, as brought about by working the butter, the fewer are the bacteria that it contains.

"The keeping quality of the butter," explained Dr. Rahn, "should be the greater the finer the distribution of moisture. A butter which is overworked should undergo less bacterial deterioration than a butter with many large droplets. These computations will not hold for molds which have the power to grow from one droplet to the other, nor for some yeasts which form mycelial structures."—*Science Service*

Two Heads Better Than One, Experiment in Thinking Shows. People working together think more efficiently on a simple problem than individuals working alone, Prof. Goodwin B. Watson, of Columbia University, reported to educators attending the recent American Association for the Advancement of Science meeting.

To test this, Prof. Watson selected four nine-letter words: "educators," "neurotics," "secondary," and "universal." These words were divided among twenty groups of students, and each group was told to see how many words, of three letters or more, it could make in ten minutes. Each individual also made words out of one of the nine-letter words by himself.

When the students worked in groups, and one person wrote down the words as they were suggested, the average for a group was seventy-five words in ten minutes. When individuals worked alone, the average was only thirty-two words, and the best record was about forty-nine words.

"It would seem fair to conclude," Prof. Watson said, "that in a task of this sort a group of from three to ten persons can be counted on to do better work than the average or best person in the group."

There is a good deal of discussion in business organizations and in colleges, he pointed out, over the comparative effectiveness of having committees and similar groups work on a task and having individuals handle the same task. The word experiment indicated that speed picks up in group thinking, Prof. Watson said, but further experimenting is necessary to prove whether groups are more efficient in handling longer and more complex projects.—*Science Service*

SCIENCE, THE INDIVIDUAL, AND THE STATE*

MARSTON T. BOGERT, COLUMBIA UNIVERSITY, NEW YORK CITY

In presenting briefly some of the many ways in which science touches the life of the individual and of the state, my illustrations will be drawn chiefly from that branch of science to which my own life has been largely devoted, namely, chemistry, although much that I shall have to say will apply also to other branches.

The scientist finds his opportunity for service usually in one or more of the following occupations:

A. In the *Dissemination of Knowledge*, as teacher, writer, or lecturer.

B. By the application of his scientific training and special knowledge to the problems of *Industry* and of *Public Service.*

C. In the *Discovery of New Knowledge*, by original investigation and research.

A. Dissemination of Knowledge

The first of these has to do with (I) educational institutions of various kinds; (II) industrial and technical museums; (III) scientific academies, societies, and similar organizations; (IV) scientific books, journals, and other publications; (V) public lectures and addresses; (VI) libraries and reading rooms.

After thirty-five years' teaching experience in the United States, there are several points which I would like to emphasize in this field, but the time available this afternoon does not permit it.

B. Industry and Public Service

The part which chemistry plays in industry is enormous. With the exception of those involving purely mechanical processes, there is scarcely an industry which is not either directly or indirectly dependent upon the skill of the chemist; but this phase of the subject will be discussed in a later address and so need not be considered now.

Occasionally, self-appointed critics refer rather scornfully to the college professor as an absent-minded and eccentric being, so engrossed in his scientific investigations as to be utterly useless for anything else, and professional politicians often ridicule the idea of university teachers becoming great statesmen or inspiring leaders of their people. I have always insisted, on the contrary, that the training in the "scientific method," should be particularly valuable to anyone entering upon a career

* The first of a series of three non-technical lectures delivered at The Charles University, Prague, by Dr. Bogert, in the capacity of first Visiting Carnegie Professor of International Relations to Czechoslovakia. The editor has taken the liberty of deleting the introductory remarks which were directed more particularly to Dr. Bogert's Czechoslovakian audience.

of public service, with its manifold, exceedingly complex and difficult questions, and if I were to select an illustration to prove my case, no better one can be found than that of your own country, for Czechoslovakia owes its independence, in part at least, to an American university professor, and its marvelous progress to the enlightened and inspiring leadership of one of its own university professors, supported by a Cabinet containing many other professors. Is it strange that the teachers in both lands are proud of the fact that President Masaryk and President Wilson were university professors, or that the career of the teacher has thereby won new honor and distinction?

C. Discovery of New Knowledge

This is, of course, the main function of research laboratories and institutions, which may or may not be affiliated with educational establishments or with the state. These are the "shock troops" of science, always on the firing line and ever penetrating deeper and deeper into the hostile territory of those common enemies of mankind—ignorance, superstition and darkness, poverty and famine, disease, pestilence, and death.

In the United States we have the highest admiration for the numerous splendid contributions which the chemists of Czechoslovakia are making, both to the dissemination of knowledge and the discovery of new facts. You have good reason to be proud of these scientists, for they are bringing honor and distinction to their country and their profession. In many striking ways they are aiding in the advancement of the world, and other nations, as well as Czechoslovakia, are directly benefiting thereby.

In the dim ages of antiquity man searched the corners of the then known world for precious dyes, spices, and perfumes, great caravans made long and perilous journeys and galleys plied the seven seas on similar errands, for only kings and nobles, or the richest of the proletariat could afford these luxuries. But today, science, the greatest of all democratizers, has brought these and thousands of other equally precious substances within the reach of even the poorest of our people. The "Philosopher's Stone," the "Grand Elixir," or the "Magisterium," as it was variously called, sought so eagerly by the alchemists of the Zlata ulicka, and which was not only to transmute baser metals into gold but also to restore the dying to life, has indeed been found—in the trained intelligence and the fertile imagination of the scientific investigator. Its name is Scientific Research, and it is daily transmuting baser materials into articles of inestimable value to the community, relieving human suffering and saving human life. It is the mainspring of our progress and the measure of our civilization. Louis Pasteur it was who said:

> Laboratories and discoveries are correlative terms. If you suppress laboratories, physical science will be stricken with barrenness and death, it will become mere powerless information instead of a science of progress and futurity; give it back its laboratories

and life, fecundity, and power will reappear. Ask that they be multiplied and completed. They are the temples of the future, of riches and of comfort. There humanity grows greater, better, stronger. . . .In our century science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring daily discussions of politics seem to be our guide—empty appearances—what really leads us forward are a few scientific discoveries and their applications.

And the late Sir James Bryce, in an address to the members of the National Academy of Sciences, said:

You men of science are really the rulers of the world. It is in your hands that lies control of the forces of activity; it is you who are going to make the history of the future, because all commerce and all industry is today far more than ever the child of science . . . It is in your hands that the future lies, far more than in those of military men or politicians.

Many of the things which seem impossible today will be matters of such everyday knowledge a few years hence as not even to evoke passing comment. As a child, my parents used to read me a poem called "Darius Green and His Flying Machine," written in ridicule of the possibilities of aviation. As a boy, I read with great delight Jules Verne's "Twenty Thousand Leagues under the Sea," which foreshadowed submarines but was regarded as equally impossible and fantastic. Over thirty years ago, Bellamy's book, "Looking Backward," appeared and was regarded as another wild flight of the imagination. For in it was suggested the possibility of what we know today as "radio." It was, however, to take a hundred years to achieve this. Actually, it has taken less than one-third of that time. The late Elbert Hubbard used to say that "in these days, the man who says that a thing cannot be done is quite apt to be interrupted by some idiot doing it."

The value of new facts carefully determined and recorded is not always immediately evident. Years may roll by before they are utilized.

The dead stars in the sky are still beheld,
Though centuries gone by their light was quelled,
From such unreckoned height doth fall their light,
So, thoughts that but barren seem and without goal
May, like these dead stars, gleam in someone's soul,
When they that writ them sleep unfathomably deep.

In recent years there has been much thoughtless railing by the newspapers against science as inimical to the well-being of the race, because of the evil uses to which it has frequently been put. Scientific knowledge is power and, like any other kind of power, political, financial, or what not, may be used either benevolently or malevolently. Of course, power in itself is neither intrinsically good nor bad. It is only the purpose it serves which can be so described, and this carries the responsibility back to where it belongs, namely, to the individual employing it. The greater the power under man's control, the greater his possibilities for good or

evil, and the heavier his responsibility. As well might one condemn religion, because in its name have been committed some of the bloodiest and most revolting crimes in all history. A scientific invention or discovery may be used either for or against humanity, and no one can foretell what will be its final balance sheet. It is manifest that if scientific discovery and the dissemination of scientific knowledge were to be limited to those facts which could be guaranteed to have only benevolent applications, there would be no scientific discovery or dissemination of scientific knowledge.

Carbolic acid served man long and faithfully as a general antiseptic and disinfectant, for the healing of the sick and the eradication of disease, before it became the source of the picric acid wherewith men destroyed one another. From it originate also such beneficent drugs as salicylic acid and derivatives (aspirin, salol, salophen, etc.), phenacetine, phenolphthalein (Phenolax, Exlax, etc.), and the like, such dyes as the sulfur blacks, which are surpassed in tonnage only by indigo, as well as photographic developers, synthetic resins of the bakelite, condensite, and redmanol types, synthetic tannins of the neradol class, wintergreen and other perfumes, and many other products which minister to our needs or contribute to our pleasures; while, on the other side of the ledger must be entered also such items as chloropicrin and other toxic gases.

Similarly, aniline, perhaps the most important of all coal-tar intermediates, is the raw material for the manufacture of such drugs as acetanilide (antifebrine), antipyrine, salvarsan, and neo-salvarsan; of hosts of beautiful dyes which are used to color our fabrics, flags, and uniforms, to form also the basis of paints and inks, or as bacterial stains to enable the physician to detect and determine many dangerous diseases. From it are prepared also the perfumes of the rose, jasmine, and narcissus, such war munitions as explosives of the T.N.A. and tetryl groups, and poison gases like diphenylchlorarsine and phenylcarbylamine chloride.

The chlorine which served for the manufacture of the deadliest gases used during the World War is the same chlorine as was used to save soldiers' lives by sterilization of the drinking water, to prepare such a blessed general anesthetic as chloroform and such healing wound-disinfectants as Chloramine T and Dichloramine T. The rabid prohibitionist, lying in the hospital and about to undergo a major surgical operation, as he sinks into painless unconsciousness under the influence of the ether administered, thanks his Maker for such a boon to suffering humanity and falls asleep blissfully ignorant of the fact that this ether was manufactured from the very alcohol which he has been damning so bitterly and so uncompromisingly for, lo, these many years.

The microscope lenses requisite for the study and identification of disease do not differ essentially from those used by the submarine com-

mander in his periscope, to enable him to direct the torpedo which sends to their death thousands of innocent and unsuspecting victims, or from those which aid the aeronaut to sight his aerial torpedo before loosing it over some helpless and hapless city.

Potent drugs, like morphine, chloral, or cocaine, may prove a curse or a blessing to the user. Explosives are necessary not only in war, but without them mining and great engineering operations would be impossible in time of peace.

And so example after example might be cited in support of the assertion that scientific discovery and progress are not necessarily hostile to civilization, that on the contrary they have been among the greatest agencies for the advancement of civilization, and that without them any nation will quickly fall out of the race and be eliminated.

To illustrate how the chemist works and what he has already accomplished, as an indication of what he may reasonably hope to achieve in the near future, let us consider but a single field, namely, that of health and disease, for that concerns all of us, whether individuals or state.

Not so many years ago, the physician was heavily handicapped in his endeavors to relieve human suffering by being entirely dependent upon natural products for his Materia Medica. Since Nature never standardizes her products, which vary with changing conditions of climate, soil, temperature, and the like, these natural remedies were of uncertain and varying composition. The popular superstition that the medicinal value and virtue of a pure chemical compound is modified in some mysterious but positive manner by the source from which it is derived is as old as the hills. The famous "English Drops," a drug which really consisted of nothing but ammonium carbonate with a little ethereal oil, sold for high prices up to the close of the 17th century, because it was stated by some that the ammonium which it contained was obtained by the dry distillation of silk, while others even went so far as to maintain that it was prepared by distilling five pounds of the skulls of persons who had been hanged (or who had come to some other unnatural end) with two pounds of dried vipers, hartshorn, and ivory. We smile at this, and yet the same kind of superstition still retains its hold upon the community and materially retards the introduction of really valuable remedies.

The chemist early recognized the probability that the physiological action of these natural remedies must be due to certain definite chemical compounds which they happened to contain, and he set himself at once the task of isolating, identifying, and studying these so-called "active principles." The results immediately justified his predictions; many of these principles were isolated and characterized, and natural remedies could then be standardized on the basis of their content of such principles. This study led quite naturally to attempts to produce, artificially, either

these substances themselves or others of similar properties, and to determine the molecular structures, or atomic complexes, responsible for the physiological effects noted. Then, taking the information thus accumulated, the chemist cut loose entirely from natural products and set about building up in his own organic laboratory new compounds which should contain these physiologically potent structures or complexes, and his activities in this direction are evidenced by the steady stream of new and powerful drugs constantly appearing. A number of these have been mentioned already; others are remedies for African sleeping sickness (like the "Baeyer 205," or "Fourneau 309"), novocaine, veronal, luminal, trional, atrophans of various kinds, mercurochrome, caprocol, and many hundreds more.

Even the enzymes, vitamins, endocrine, and other glandular secretions, immunizing sera, insulin, and similar vital products, must owe their physiological activity to certain definite chemical components, and when these constituents and their molecular configurations are known, their synthesis will as certainly follow as the day follows the night. I need point only to the isolation and recent synthesis of thyroxine, the active constituent of the thyroid gland.

The natural remedies are built up in the plant or animal to perform a definite function in the structure and life of those organisms, and the fact that they may be of therapeutic value when taken into the human system is purely fortuitous. The synthetic remedies, on the other hand, are built up with the sole object in view of producing substances which shall contain physiologically active groups, or so to modify a compound as to enhance its therapeutic value. It is not necessary, therefore, to reproduce the entire complicated molecule of such an alkaloid as cocaine, for example, if similar physiological effects can be secured with simpler structures. Thus, some of the modern local anesthetics contain only a fraction of the cocaine molecule, yet are more powerful and less dangerous. Further, these synthetic remedies are pure individual substances, and not mixtures like the old natural remedies. This permits easy detection of adulteration, accurate dosage, and exact determination of physiological effects with reference to chemical constitution. Of the man who still believes in old-fashioned natural remedies, I would ask what natural remedies he has to take the place of the chemist's general anesthetics, antisyphilitics, or remedies for sleeping sickness?

In his fight against disease and death, the physician has no more potent or resourceful ally than the organic chemist and that fact is being increasingly recognized. It has been asserted on good authority that the discoveries of the chemist Pasteur have saved more human lives than were lost in the World War. During that war, my own country lost about 50,000 soldiers, but in the same period 400,000 died from influenza and

180,000 from cancer. The total deaths due to the World War, among the various nations which took part, have been estimated at as high as 10,000,000. But in the year 1347, the Black Death was brought from the Crimea to Genoa by an Italian advocate named Gabriel de Mussis, and within the short space of 24 months 25,000,000 people had fallen victims to that dread pestilence. In problems relating to disease and death, it is obviously and tragically true that thousands of human lives and the alleviation of an incalculable amount of human suffering depend upon the speed with which we can reach some of these goals toward which we are striving. It is your life and the lives of those nearest and dearest to you that are at stake.

The human being represents the most wonderful coöperative chemical industry in existence, the units of the organization being the separate cells. He is, therefore, a federation rather than an individual, the central seat of government being located in that bony box we call the skull. If you have ever visited the main telephone stations in any great city, like your own, for example, you must have been impressed by the tens of thousands of wires coming from all directions and marveled at the skill with which these were all brought together and coördinated in one or two main switchboards controlled by a few operators. But, compared to the ability of the human brain to receive, interpret, and file the vast number of impressions coming to it every moment of the day, the largest and most complicated switchboard yet constructed by man is scarcely child's play. Such gigantic and complex industries as your own Skoda Works, as the "I. G." of Germany, or the Standard Oil Company of the United States are not even in the same class as the human organism, whose intricacy and the delicate balance of whose numerous adjustments become the more wonderful the more intensively they are studied.

I am a firm believer in the hypothesis that what we call life is merely the outward manifestation of the resultant of the innumerable and sensitively adjusted operations of this great chemical plant we call *Homo Sapiens*. By this I mean not only the outward physical manifestations of life as represented by our daily activities, but I am also convinced that there are excellent reasons for believing that mental and moral attributes as well are the result of specific organic chemical reactions.

It is a well-recognized fact in medicine that, by the introduction of certain drugs into the system, the mentality may be seriously disturbed or deranged and even the reason overthrown; and those who have had anything whatever to do with drug addicts will testify unhesitatingly concerning the destructive effect such organic chemicals have, not only upon the physical and mental state of the victim, but upon his moral standards as well. It is true that observations of this kind have had to do mainly with destructive rather than constructive effects, and yet if we can in-

fluence these forms of vital activity in one way by the use of certain drugs, why is it not or may it not be possible to influence them equally in beneficent directions?

We are beginning to understand more clearly, day by day, the tremendous importance of food, not only upon the growth and physical development of the individual, but also upon that subtler combination we call character. Yet feeding is but one way of introducing chemical compounds into the organism, there to be subject to those metabolic processes and chemical changes which are exhibited outwardly in its activities.

It will doubtless appear to you a ridiculous and fantastic prophecy, yet I venture to predict that the time will come when it will be possible not only to combat successfully the great majority of human diseases and to increase materially the span of human life, but also, by appropriate food or by the introduction of necessary chemicals, so to modify the life functions of the cell as to produce men of physical superiority, of greater mental power, and of loftier ideals. As Slosson expresses it, "The chemist of the future may mould stature and character as a sculptor moulds his clay." Evolution represents the slow progress of man through the ages due to the influence of his environment and the survival of the fittest. Man may one day be able to bring about similar changes within the brief space of a few years or even months, when once these chemical secrets are discovered, for heredity, the origin of species, and reproduction are chemical problems. Many years ago, Jacques Loeb proved that the eggs of the sea urchin could be fertilized chemically. To quote Slosson again: "A variation of a few hundredths of 1% in the glucose of the blood may be the sole difference between cowardice and courage, and may determine whether a man is to be shot as a slacker or decorated as a hero." Nature works at a leisurely pace. Man is always in a hurry. The indigo which the plant requires a whole season to produce, I can make for you in 30 seconds, before your eyes, on this lecture table, from a few simple chemicals.

Finally, the chemist may gain control of life itself and succeed in producing living tissue. In the Rockfeller Institute today, in Dr. Carrel's laboratory, you can see tissue removed from a chicken's heart over seventeen years ago, which is still living and beating, being kept so by chemical means and, so far as can be seen, there is no reason why this tissue should not live indefinitely if the chemical treatment be continued.

In the days of the Puritans in America, their preachments were often directed to terrifying the unbeliever by threats of eternal damnation hell-fire, and the judgment to come. Yet it is neither irreverent nor sacrilegious for scientists to point out that the end of human life upon this globe may be brought about entirely through man's own God-given reasoning power. Year by year, decade by decade, he is gaining a fuller insight into the material forces which govern his universe and an ever-in-

creasing mastery over them. Undoubtedly, there are still more wonderful forces all about us concerning which we have as yet little or no knowledge. Some time the day may arrive when he will have such command over the fundamental titanic energies of the world that a single miscreant may have it in his power to loosen these forces or so to disturb the balance of the universe as to obliterate man from its surface. Another way by which man may bring about his own extinction is that already suggested in his increasing knowledge and control over the life functions of the individual, so that it may be possible some day to annihilate the inhabitants of an entire continent by the use of chemicals or other agencies which will fatally disturb or interfere with these normal life processes.

It is, therefore, because I fear that man's rapidly advancing mastery over the forces of his universe threaten to outrun his own capacity to handle safely this tremendous increase in responsibility, that I have ventured to suggest the desirability of giving more thought to the improvement scientifically of man himself, in the firm belief that with chemistry and medicine actively coöperating in such an undertaking, man can make of himself a veritable demi-god, or else he will achieve his own destruction and that of his race. There is no problem which, in its importance to both individual and state, transcends this one, and it is a problem which can be solved only by science.

UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Chemical Engineer.

Applications for junior chemical engineer must be on file with the Civil-Service Commission at Washington, D. C., not later than February 25th. The date for assembling of competitors will be stated on their admission cards, and will be about ten days after the close of receipt of applications.

The entrance salary is $1860 a year in the District of Columbia. After the probational period required by the civil-service act and rules, advancement in pay will depend upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointment outside of Washington, D. C., the salary will be approximately the same.

The duties of this position are to perform such work as routine testing, inspection of engineering material, preparing specifications for engineering material or apparatus, performing field work, making computations, assisting in conduct of experimental research tests, compiling reports, and handling technical correspondence.

Competitors will be rated on general physics, mathematics, general engineering, and chemical engineering.

Full information may be obtained from the United States Civil-Service Commission at Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.

INTERVIEWING DOCTOR X*

HORACE G. DEMING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA

Last evening I interviewed Dr. X, whose identity is disclosed as soon as you learn that he is the man any college professor might have become had he chosen to be other than a college professor. The doctor talks very freely, and—strangely then—sometimes says something. But, since he merely represents the man whom I, personally, might have been, had I drawn the proper chromosomes, his opinions are merely those that I, personally, *might have had*. That shifts the responsibility.

The doctor is very outspoken in his criticism of the spirit of recent attempts to popularize science. Let him speak in his own words:

"You fellows feel the call to tell the world about your work. Why? As a *public duty*. Yet, closely examined, this proves to mean that the public owes *you* a duty; that scientific research is becoming so expensive that it cannot develop properly without more support from public funds.

"How shall this duty be discharged? Why, by disseminating scientific information. Let lectures be given, in which simple scientific facts are put in very simple words. Let books be written in which the *practical usefulness* of science is pointed out—the great things it has done for the world—how it has given us radio, transparent pipestems, chewing-gum, rubber heels, wire-haired terriers, double sweet peas, operations for appendicitis, weather forecasts, vaccination, eugenics, and poison gas.

"You seem to think that scientific facts, as such, have a greater educational value than facts of other kinds. The fellow who has made a lifelong study of the facts about who wrote what in Patagonian literature is narrow-minded and deluded; but the bacteriologist who knows all about which organisms ferment which obscure sugars has in this a more desirable element of education.

"Attention you have, indeed, secured. Like Coleridge's Wedding Guest, the man in the street finds it useless to resist:

> 'The Wedding Guest, he beat his breast,
> Yet he cannot choose but hear,
> While thus spoke on that Ancient Man,
> The bright-eyed Chemiker.'

"But attention does not signify comprehension. Are you really giving the public a true idea of science; or, are you, in your efforts to gain a hearing, obscuring its true nature with a mist as alluring and deceptive as that golden haze which surrounded alchemy? Is there not danger that the blind credulity of medieval days, which presumed all things

* Paper delivered before the Division of Chemical Education of the A. C. S. at Detroit, Michigan, September 8, 1927, as a contribution to the Symposium on the Popularization of Chemistry.

possible to those in league with the powers of darkness, may be replaced by an unintelligent belief in the occult powers of science?

"If you were to ask *me* why your attempts at making science better understood have not been more successful, I should say: First, that you have failed to perceive that science is something more than accumulated information. Your popular scientific books ought to be something more than meaningless catalogs of the services of science in promoting material human welfare—something more than a sequence of exclamations about the glorious industrial achievements of chemistry and biology. The achievements of Aladdin's lamp were wonderful enough—but they don't mean anything.

"Rather, let us have such reviews of the course of development of science as will enable the reader or hearer to learn something of its spirit and methods; and through these to glimpse its present situation, and to some degree foresee what it is about to reveal. Might not the history of science best be presented by centering attention on its problems, past and present? The problem presented by the lodestone and compass needle. What Gilbert and others found out about that, and what this knowledge has grown into. The problem presented to Galileo by the swinging chandeliers, and what came of that—clocks, wrist-watches, the gyroscope, and the chronometer. The problem presented to Franklin by a thunder cloud —what he and others found out about the nature of electricity, and what came of that. The problem of the material composition of things—which reduced a bewildering universe to some fourscore elements. The problem of fermenting apple juice, of a cliff overhanging the sea, of a germinating seed, of the spiral nebulae. Does science need to be so dull?

"The textbook writers, you might think, would have produced books along these lines, in all the sciences. Instead, what do we find? Any book designed to sell as a textbook must be largely catalogd information. One on chemistry must begin with intangible, invisible, uninteresting gases, then pass in review a long series of colored or colorless, odorous or odorless substances, and end abruptly with the complex platino-cyanide ion. Why these facts are worth studying, or what chemistry is good for in the scheme of the universe, you might never guess. Such a book will not fail to tell us that ferrous sulfate contains seven molecules of crystal-water and is used for killing weeds, that manganous chloride tetrahydrate crystallizes from aqueous solution in deliquescent, monoclinic needles; and that columbium occurs in nature as columbite, which is an isomorphous mixture of ferrous metacolumbate and ferrous metatantalate. Or again, in an attempt to be practical, such texts may give us reliable directions for the preparation of dithionic and trithionic acids, roach powder, magnesida alba, and sympathetic ink.

"Science presented *problem by problem* and *principle by principle*,

instead of fact by fact, would have plenty of both human interest and romance. Human interest does not attach to practical utility alone, but might perhaps be secured by presenting problems—such a thing as the synthesis of a new anesthetic, or the discovery of the laws of heredity in the guise of a detective story; the problem stated, evidence weighed, clues followed out. As for romance, writers in that field certainly leave one with the impression that it is largely concerned with the *methods* employed in the winning of a girl, and that it takes no note of whether she may afterward turn out to be of practical utility in the management of a home.

"Again, as I listen to your popular scientific addresses, it seems to me that you underrate the capacity of the public for getting a real command of scientific things. Take note of the existence of several million wireless amateurs—boys of fourteen who speak familiarly of reactance, impedance, and electrostatic capacity, and know what they are talking about. Psychologists have discovered—and that quite outside of the ranks of chemists—about one person in a hundred with a very superior intelligence. That means an audience of a million, in this country, for those with the skill to reach it. There are more amateurs in all branches of science—people, that is, with a keen interest, though but slightly trained—than most of you suspect. I, a practicing physician, have found time to do a little reading in chemistry and biology. I know a portrait painter who has made a thorough study of optics; and a lawyer, down the street, finds recreation in Bessel functions and Fourier's series.

"One result of the existence of such people is that you will need to use more caution in your statements of what science is about to do. You cannot give out such wild-eyed interviews as those recently delivered to the public press by a prominent manufacturing chemist and get away with it. The chemist, he stated, was about to abolish sleep. 'Methought I heard a voice cry, "Sleep no more! Macbeth hath murdered sleep!"' Again, that the biologist will presently extend human life indefinitely thus making vain the promise of the fifth commandment. Or that the surgeon, by mechanical alteration of our internal laboratory, is about to enable us to take our food in the form of tablets of synthetic substitutes for the items in our present bills of fare.

"Now everyone knows that such wonders are not those of the immediate future. Why talk of doing away with sleep, while we are still unable to state what sort of constitution a substance has to have in order to serve as a soporific; while we are not sure why certain substances produce anesthesia, though others do not; while we have no clear proof that the phenomena of fatigue are due to the production of definite toxic substances? Why talk of extending life indefinitely, while the most widely heralded achievements of recent science have concerned the isolation of

substances secured ready-made from the glands of animals; and while even these are as yet mere palliatives for incurable disease? Why talk of synthetic food, when hardly one of the important substances that feed and clothe us has been synthesized; and while the reactions by which starches, sugars, and proteins are built up so smoothly in the leaves of green plants have only just begun to be unraveled?

"In many another field of organic synthesis must we stand humbled and abashed before the handicraft of Nature. We produce a weak fiber in imitation of silk, by torturing the cellulose molecule with powerful reagents; but for something fit to withstand wet weather we must still resort to the silk-worm. For wood and paper we must still sweep the forests from our mountain-sides. For serviceable rubber we must still brave the tropics. And still for leather we must sally forth—though perhaps not personally—and knock a bullock on the head.

"Recent chemical propaganda has been the worst offender in claiming too much for modern science. 'The chemist long ago invented soap and paper. He taught us how to make porcelain and cement. He has given us steel.'

"Ah, no! History has it otherwise. Soap and paper were invented long before the man who rendered tallow had been taught that his art bore any relation to that of his neighbor who split papyrus reeds. Porcelain came into existence many centuries ago before its constituent materials had been chemically identified. Cement, most serviceable and enduring, went into the ancient Roman aqueducts. Hardened and tempered steel played an important part in that famous interview between King Richard and the Soldan, many hundreds of years before anyone heard of ferrite and cementite.

"My criticism then comes to this—that in your efforts to popularize science you should have a more intelligent vision of the way to go about it, based on a more vivid realization of the real nature of science itself; and that you should take care to present a *truthful* picture of its present situation and immediate prospects. The education of the public along scientific lines must be begun by the re-education of the scientist himself. Let him learn to think of science as a *method of thought*, rather than a collection of facts and recipes. Let him learn that the boundaries between the several sciences are but artificial ones, made for the convenience of the specialist, and best overstepped when you come to present scientific ideas to the general public. To the riddle of the Sphinx proposed by Nature, one science may well speak for another:

> 'Through a thousand voices,
> Spake the universal dame,
> Who telleth one of my answers,
> Is master of all I am.'

"Let the scientist take some interest in the recent movements to extend the scientific point of view into fields still beclouded by age-old prejudice, into ethics, psychology, history, and politics. Let him join with the forces that make war on lingering superstitions that discredit this scientific age—astrology, chiropractic, fortune-telling, phrenology, hypnotism, palmistry, memory systems, mental telepathy, spiritism, numeration, physiognomy, faith healing, and absent treatment—for only in proportion as such things decrease will science begin to realize its possibilities in transforming the lives of men."

The interview at an end, I went home that evening resolved to set about my own re-education. Applying some of the remarks of the doctor to my own specialty, I began to see that the thing that makes chemistry worthwhile is not its practical results, but the *methods* that won them; not materials but *thoughts*. Its triumphs are not in dyestuffs and synthetic medicines, but in the revealing of a world beyond the reach of the ultra-microscope; not in liquid air and alloy steels, but in the laws that govern the transformations of matter, throughout the universe.

In our teaching, then, and in all our efforts to popularize science let us make scientific achievements mean something by relating them to the thought that produced them: *That beyond the limits of the unaided human senses lies a land that the human mind may still traverse, with step serene and confident.* When we seek to arouse interest in scientific work, let us speak less of its practical utility than of its intellectual beauty—less of its importance in modern life than of its grandeur of thought. Over the gateway that leads to the scientific realm, let us erase the promise of mere material blessings and write something like this:

Peace unto thee, O pilgrim! This the gate
Of Science, mistress beautiful and fair.
Her fullest favors win, who dedicate
A lifetime to her service, and forswear
Much other wisdom men may hold of weight.
But this thy privilege, to be aware
By what delightful art of sorcery
The tender violet doth fabricate
Her green and gold and azure fragrancy
From somber elements of earth and air.
With sharpened vision, thou shalt trace the flight
Of bits of stuff too subtle for the way
Of human sense. Thy hand shall find delight
In artful craftmanship; thine eye survey
A magic realm, unglimpsed by mortal sight;
Thine ear respond to harmonies, expressed
By vibrant atoms, rank on rank arrayed,
Within the ardent diamond's flaming breast;
Thy soul in exaltation shall be stayed,
Perceiving selfsame laws, made manifest

By living cells, in droplets circle bright,
Or starry mists, aglow, in distant depths of night.
Be this thy recompense.

New Insect-Killing Chemicals Said Less Dangerous Than Arsenic. Greater deadliness to insects and kindred pests but less danger to human beings and warm-blooded animals are the virtues claimed for two new types of spray chemicals by Dr. Simon Marcovitch of the Tennessee Agricultural Experiment Station, who spoke before the recent meeting of the American Association of Economic Entomologists.

The new insect poisons on which he conducted his research are sodium fluoride and sodium fluosilicate. He tried them on grasshoppers, mosquito "wrigglers," and one or two other small creatures, and also on rabbits as substitutes for human subjects. He found that the insect life, in general, succumbed to smaller doses of the new compounds, but that to the rabbits they were only about one-ninth as poisonous as the standard arsenical spray materials now most widely used. The alleged poisonousness of arsenical residues on sprayed fruits and vegetables has been a subject of much debate of recent years, but Dr. Marcovitch is of the opinion that the new sprays make it possible to be on the safe side.—*Science Service*

Biologist Calls Coffee Beneficial Beverage. Devotees of the coffee cup will welcome the glad tidings, announced by Prof. Ralph H. Cheney of the biology department of New York University, that coffee is not only harmless but beneficial.

"Evidence derived from my study of the effect of coffee on animals and man," Prof. Cheney declared recently, "indicates that the properly prepared beverage is highly advantageous with respect to over 90 per cent of normal individuals. Judging from the effect of aqueous solutions of caffeine or of the coffee beverage taken through the stomach in the 1.5 grain quantities such as exist in the average coffee cup, the reasonable use of coffee is a great blessing to man. To be sure, caffeine is a drug and its use can be abused, but acute injury, as far as the caffeine content is concerned, would necessitate the consumption of over 150 cups which is, of course, ridiculous.

"Psychological responses of amiability and a sense of well-being and good cheer are undeniable accompaniments of the coffee beverage and the physiological effects are also non-injurious and gratifying. Temporary relief from hunger and fatigue is a general result and light headaches, due to other than gastric disturbances, are commonly alleviated. Coffee serves as a mild stimulant of the heart, brain, and muscles, thereby accomplishing greater power and coördination in mental and physical endeavors.

"The outstanding fact to be heralded in favor of coffee is the absence of any after-effect or subnormal, recuperation period. It does not seem to be habit-forming since satisfactory stimulation does not require continually enlarged quantities. No other beverage produces equal stimulation without deleterious after-effects. On this basis, it is safe to say that coffee, prepared by subjecting the ground bean to water just below the boiling point for 5 minutes or even somewhat longer in most household percolators, is not injurious to adults in normal health who show no acute idiosyncrasy regarding caffeine or other substances in the beverage."

Coffee is an impressive example of a plant, Prof. Cheney pointed out, whose economic importance has been raised to great heights by its successful planting in a locality entirely foreign to its natural distribution since it is indigenous to Africa and Asia and is raised principally in Brazil and Colombia. The United States is the largest consumer, coffee imports being exceeded only by sugar and raw silk.—*Science Service*

A SKETCH OF DR. JOHN WILLIAM MALLET, AS A CHEMIST AND A TEACHER*

F. P. DUNNINGTON, UNIVERSITY OF VIRGINIA, UNIVERSITY, VIRGINIA

Dr. Mallet was born at Dublin on October 10, 1832. His grandfather was John Mallet of Devonshire and his father, Robert Mallet, a civil engineer and a Fellow of the Royal Society. Under his father's guidance, and given free rein in an excellent scientific library, he early developed a taste for scientific studies. To use his own language: "Reading nearly all of the volumes of Thomson's *Annals of Philosophy* was serviceable in starting the idea that our knowledge of nature is not complete and embodied in textbooks, but that it rests on observation and experiment, is constantly growing, and is always subject to modification and correction."

At the age of sixteen he had the privilege of private laboratory instruction under Dr. James Apjohn, while attending his lectures on chemistry. In 1850 young Mallet published in the *Journal of the Geological Society of Dublin* his first contribution to chemical annals: "A Chemical Examination of Killenite." This analysis copied in Dana's "Mineralogy," 1870, shows that he alone had detected lithia in a specimen of this mineral, and doubtless this circumstance led to the redetermination of the atomic weight of lithium in 1856.

Between 1848 and 1850 Mr. Mallet assisted his father in experiments upon the velocity of transmission, in rock and in loose earth, of the shock from a gunpowder explosion. From this work, no doubt, began his special interest in the use and manufacture of gunpowder, which bore fruit a few years later, in his very capable direction and supervision of the making of ammunition for the Confederate States. At this same period he collated, through much reading in different public libraries, the material for a catalog of 597 pages on earthquakes extending from 1606 B.C. to 1842 A.D. This was accomplished before he was twenty-one years of age. The discussion and publication of this report to the British Association was made by his father.

In 1851 and 1852 Mr. Mallet worked in the laboratory of Professor Wöhler and received the degree of Ph.D. at Göttingen; his thesis being a report upon the chemical examination of Celtic antiquities found in the museum of the Royal Irish Academy of Dublin. This work was based chiefly upon thirty-eight analyses of metallic articles. During two vacations he made a pedestrian trip, in German student fashion with knapsack and staff, in company with two Americans, William S. Clark and N. S. Manross, through the mining district of Harz Mountains and some manu-

*Paper delivered before the joint meeting of the Section (now Division) of History of Chemistry and the Division of Chemical Education of the A. C. S. at Richmond, Virginia, April 13, 1927.

facturing cities of Belgium and Holland, so obtaining much information upon certain chemical manufactures and metallurgy.

Returning to Dublin in 1853, Dr. Mallet graduated as B.A. at Trinity College, being First Senior Moderator and Gold Medallist in Experimental Physics for that year. Following this he came to the United States to collect information for his father as to the Ericsson Caloric Engine. Here he met his friend Dr. W. S. Clark, then professor of chemistry at Amherst, Massachusetts, and shortly thereafter was elected professor of analytical chemistry in that college. In the Fall of 1854, Dr. Mallet was appointed chemist to the Geological Survey of Alabama and professor of chemistry at the University of Alabama, and while there, he published in the *American Journal of Science* the analyses of a number of rare minerals. In 1860 he sent to the Royal Society an extended paper on the chemical and physical conditions of the culture of cotton, afterwards published in book form in London. It was in this investigation that he published a somewhat elaborate study of the physico-chemical properties of soils, demonstrating the powers which different soils possess of retaining some and rejecting other constituents of water solutions of salts passed through them, and so explaining the difficulty of removing some substances from a soil by "washing."

Prof. Mallet remained at the University of Alabama until 1861. In July, 1857, he married Mary E., eldest daughter of Judge John J. Ormond, of the Supreme Court of Alabama. This union fixed his fealty to this country, calling him to enlist as a private in the Confederate cavalry, and soon thereafter he was commissioned as Aide-de-Camp on the staff of Gen. R. E. Rhodes, in which position he had some trying service at the front. Dr. Mallet, then, as throughout his life, a British subject, was given general supervision of the manufacture and supply of ammunition for the Southern Confederacy in which capacity he was most intensely engaged during that war. Some idea of the range of this work may be gathered from the subject of his many reports to Gen. J. Gorgas, Chief of the Ordnance Department: substitutes for mercuric fulminate in filling percussion caps; deterioration of gunpowder exposed to moist air; shells with polyhedral cavity; time-fuses for use at very long ranges; an electro-magnetic instrument for determining the rate of burning of time-fuses, etc. Possibly this familiarity with ordnance was a factor in the training of the considerable number of his students who have been employed in making explosives.

After the surrender in 1865, Col. Mallet was employed in the search for petroleum in Texas, and later became professor of chemistry in the Medical Department of the University of Louisiana, where he organized a practical laboratory course in chemistry for medical students. During the three years passed here, he devoted much time to the study of medicine and, upon leaving, received the degree of M.D. This study of the chemical

side of medicine in after years led to a number of investigations in physiological chemistry and hygiene.

In the Spring of 1868 Professor Mallet came to the University of Virginia to organize the School of Analytical and Industrial Chemistry, and in this he conducted what is thought to be the first systematic course of industrial chemistry in the United States. Here he built up the school from which have come many of the professors of chemistry in the colleges of the South and numbers of industrial chemists. In 1872, upon the death of Dr. S. Maupin, Dr. Mallet was made professor of general and industrial chemistry, which work, with a short interval in 1883–84, he conducted with ever-increasing ability and distinction until his retirement as emeritus professor in 1908.

Dr. Mallet, while having no oratorical gifts, was one of the best of lecturers, punctual, deliberate, systematic and concise, sparing no pains to prepare each illustration and present every thought with decisive and conspicuous clearness. To use his own words, "In teaching a science one should always have in mind the steps by which mankind at large has gradually advanced in knowledge, and should carry the pupil not formally but unconsciously over pretty much the same ground." For many years here, he delivered two courses of lectures, one in general chemistry, introduced by a study in chemical physics, covering the ground in three lectures each week, of an hour and a half each, throughout the session of nine months. In the words of one of his students,[1] "These lectures were a model of precision and continuity. There was no repetition of language or substance, he never hesitated for a word or a thought, he was never known to fail or bungle in the least in any illustrative experiment he undertook. These lectures in themselves were models of perfection, the matter presented was given so clearly, so definitely and so accurately that an attentive and intelligent man was required to do little else than take a few notes in order to refresh his memory. So impressively were the principles of chemistry photographed on his hearers' mental vision that the facts as well the scientific spirit they involved remained indelibly etched on the mind."

The second course in industrial chemistry was presented in the same number of lectures and in the same clear and efficient manner. There was no endeavor to give any technical training in any of these industries, but solely to describe the process followed and exhibit the materials illustrating the stages of transformations while explaining the chemical changes through which the native or crude material is carried until finally transformed to the finished product. The materials employed as illustrations in these lectures were collected by purchase and through solicitations of Dr. Mallet from foreign governments, large manufacturers, per-

[1] William H. Echols, in *Alumni Bulletin U. Va.* Jan., **1913,** p. 3.

sonal friends, and friends of the University. Thus was accumulated a large and valuable industrial museum which, in several respects, was not equalled in this country. On the night of January 26, 1917, the building which housed this collection was wholly destroyed by fire, so making an irreparable loss of this monument to his energy, knowledge, and efficiency.

"It was to the special students in the analytical laboratory that Dr. Mallet was revealed as the great scientist. His exceeding care, power of observation, conservatism and accuracy of thought, were here brought into intimate view. His fine intuition in a problem, his fertility of resource and suggestiveness in processes, his infallibility of experimentation, eliminating loss of time, his generosity, patience, dignity and gentle kindness, his ever ready help and sympathy won not merely the absolute confidence and respect of his men for the unquestioned master, but their admiring and lasting affection."[2]

The writer was in daily intercourse with him for forty years and the only sarcasm ever heard from him was after listening to an address of an hour's length, proposing to elucidate the teaching of evolution. I remarked to Dr. Mallet, "I could not make anything out of that address;" he replied, "That is most natural, for there was nothing in it."

Long is the roll of those who will ever recall with thankfulness the privilege of sitting under his teaching, realizing they were obtaining some insight into the wonders of nature from a master mind and master worker; many, too, here received an inspiration which, in after years, led to vigorous research and confident initiative in the pursuit of their profession. For forty years Professor Mallet continued his teaching here. With mind and body trained to full control, his daily program of life passed into peculiar uniformity of habits; absolutely punctual to all duties and thorough in every undertaking, with no idle moments. As the outcome of this continual diligence he accomplished a very large amount of work of enduring value. He published in all over 200 hundred articles[3] upon unfamiliar chemical compounds, unusual minerals, meteors, mineral waters, chemical and physical phenomena, and a number relating to the chemistry of medicine.

In 1877 he was elected a Fellow of the Royal Society of London and in 1880 presented to this society a revision of the atomic weight of aluminum, so changing this figure to 27.0 in place of 27.2; and in 1889, a revision of the atomic weight of gold, making it 196.9 in place of 196.7. In this investigation seven different series of determinations were employed. The highest of these gave 197.225; the lowest 196.722; the mean being 196.910. This article printed in full in the *American Chemical Journal*, Vol. XII, No. 2, presents what may well be taken as a model for the most refined of analytical procedure and thoroughness.

[2] *Loc. cit.*, p. 5.

[3] *Loc. cit.*, Oct., 1923, p. 432.

As analytical and consulting chemist his services and advice were often sought. In 1880 under the direction of the U. S. National Board of Health, Dr. Mallet conducted an investigation of the chemical methods in use for the determination of organic matter in potable waters. This considerable undertaking required more than a year, with the aid of three assisting chemists: Dr. William A. Noyes in the laboratory of Johns Hopkins University, Dr. Charles Smart, U. S. A., in Washington, and Dr. J. A. Tanner, U. S. N., at the University of Virginia, all working upon specimens of each of these waters at the same time. The results of this investigation (on 160 samples) were published in the Report of the National Board of Health for 1882. In this monumental work he established some degree of harmony and restored confidence in a field of analysis where, from conflicting judgments, a remarkably bitter discord had arisen between some very enthusiastic and capable chemists.

Among many appointments of honor and trust, Dr. Mallet was upon three occasions on the Assay Commission of the United States, a Judge of Awards at the International Exposition of 1876 at Philadelphia, also officially connected with the expositions at Chicago, 1893, and at St. Louis in 1904; and a member of the American Committee for the International Congress of Applied Chemistry for 1903 at Berlin and for 1906 at Rome. He was one of the founders of the American Chemical Society and was President in 1882. He was also a fellow or member of eighteen other scientific societies of national repute in the United States and foreign countries.

Dr. Mallet's work went outside of the routine that characterizes the lecture room and the laboratory and included the writing of many articles and papers covering a variety of subjects connected with his profession. He delivered many addresses, mostly of a technical character; while his reputation as a toxicologist caused him to be sought as an expert in a number of important criminal and quasi-criminal trials. He submitted a number of reports upon the water supplies of towns and cities, reviews of books for the *American Chemical Journal*, reviews of more recent advances in the applications of chemistry, and addresses to medical societies.

After teaching for fifty years, Dr. Mallet accepted the offer of a retiring allowance from the Carnegie Fund, ceasing to teach, but continuing active in his profession up to his last sickness. He never strove for place or power, but, in all positions and under all circumstances, quietly and simply did his duty to the best of his very superior ability, with absolute integrity and no thought of self, but with utmost consideration for others. He was a devout Christian, a member of the Protestant Episcopal Church, very reserved, but very direct in expression of his faith when there was any occasion for it. After a brief illness, Dr. Mallet closed his useful and honored life on November 6, 1912, at the University of Virginia.

Most appropriate is the inscription on his tomb: "*Doctor Miles Vir Nobilis.*"

Impure Gelatine Makes Movies Possible. The millions of dollars invested in the movies and the pleasure of the millions of people who daily attend them is based on chemical impurity in gelatine. This announcement, in effect, was made in a lecture given in conjunction with the meeting of the American Association for the Advancement of Science, by Dr. C. E. K. Mees, director of the Research Laboratory of the Eastman Kodak Company.

"It has recently been found," said Dr. Mees, "that the sensitiveness of films is not due to the grains of silver bromide only but is in some way connected with the presence on these grains of specks of some other substance, and the Kodak Research Laboratories after a long and careful study have found that these specks are produced by an accidental impurity present in the gelatine. This impurity is derived from the plants eaten by the animals from whose skins the gelatine is made. There is only a very small amount of it in the gelatine, but it is a compound which contains sulfur, and when the gelatine is used for making the film, the sulfur reacts with the silver bromide and produces specks of silver sulfide on the crystals.

"In some way or other these specks increase the effectiveness of the light to which the film is exposed in the camera and enable the light to change the silver bromide so as to form a trace of metallic silver. Then this silver acts during development as a nucleus on which more silver can deposit by the chemical process until the whole of the silver bromide crystal is turned into silver. Each of the original crystals of the film therefore after exposure to light becomes a grain of silver in the developed film, and it is of these grains of silver that the image projected on the screen is composed."—*Science Service*

Vitamin D Found in New Hiding Place. Vitamin D, the radiation-generated substance that prevents the development of the bone-disease rickets in children and young animals, has been traced to a new lair by Dr. Walter A. MacNair of the U. S. Bureau of Standards and Dr. C. E. Bills of Evansville, Ind.

Recent research has shown that vitamin D is produced when a substance known as ergosterol is subjected to the invisible ultra-violet rays. Not the whole range of the ultra-violet is thus able to generate the vitamin, but only certain zones or bands of wave-lengths. These wave-length bands are also able to prevent rickets in young animals when turned directly on them, instead of on the food which is later fed to them.

Ergosterol is a comparatively new substance which is extracted from cholesterol, a material that has been known for a long time. It occurs associated with the fats in animal bodies. It was formerly thought that cholesterol was the seat of vitamin D activity, but after the art of extracting the ergosterol from it was perfected, the cholesterol seemed to be inert and unable to form the vitamin even when subjected to ultra-violet raying. The conclusion, therefore, was that ergosterol could form vitamin D, and that the cholesterol from which it had been extracted could not.

But now Dr. Bills has been able to obtain some degree of vitamin D activity from cholesterol, freed from ergosterol, and on examining the effects of the rays with a spectrograph, Dr. MacNair has found that certain wave-lengths of ultra-violet light are absorbed by it. This may indicate that cholesterol after all has some capacity for forming vitamin D, although Dr. MacNair inclines to the opinion that it is more likely that it still contains as an impurity another substance as yet unextracted and unidentified, possibly of the same order as ergosterol.—*Science Service*

MORE SCIENTIFIC EDUCATION: LESS EDUCATIONAL MEASUREMENT

FRANK B. WADE, SHORTRIDGE HIGH SCHOOL, INDIANAPOLIS, INDIANA*

My title seems to imply that there is coming to be some sort of conflict between the ever-increasing wave of educational measurements and the teaching of science. It is because I suspect that to be the case that I have chosen the kind of title that I did. It seems to me that this fever for testing is but a symptom of a deep-seated disease in American educational methods. In the recent report of the Carnegie Foundation for the Advancement of Teaching, on "The Quality of the Educational Process in the United States and in Europe," I find what I think is an account of the disease itself. In discussing the faults of our secondary schools the report cites, as the third of four defects, the following, "The curriculum is a rope of sand, without texture or organization. Effective organization through related ideas is thereby sacrificed *to the mere registering of information*." The italics are mine. Again we find, "For fear of evaporation the process is checked up at once-daily recitation, written review, monthly test, and term examination. These concluded, responsibility ceases, and 'credit' is recorded, of which no future misstep, even though it discloses total ignorance, can ever deprive the pupil." In contrast with this state of things the Carnegie report tells us that in Europe "The pupil who knows from experience that a new fact or a principle will reappear year after year in modified forms or with enlarged applications confronts it in an attitude unlike his who believes it will be shelved forever after the next term examinations. It is to his obvious interest to understand it. *There are no tests or examinations in the American sense from one end of the curriculum to the other.*" Again the italics are mine.

May I say at once that I hope and expect to find in you a sympathetic audience and one that has little need of what may seem like a warning message. It is because it seems to me that there is need in various quarters for consideration of this topic that I wish to have it go on record in the *Proceedings* of the Academy at this time. Surely we members of this State Academy of Science should be concerned about the best methods of inculcating the scientific spirit in the students who are one day to take our places, whether in scientific education, research, or applied science.

May I make it clear at this point that my remarks are intended to apply solely to conditions in secondary education? Every teacher should stay within the field with which he is familiar.

Like a preacher I have taken a text for my discourse. Unlike the preacher, however, I did not find my text in the Holy Scriptures. It came

* Address of the retiring president of the Indiana Academy of Science at Notre Dame, Indiana, on Dec. 2, 1927. To be published also in the forthcoming *Proceedings* of that body.

rather from an Omega Oil advertisement of some twenty-five years ago. Some of you will recall the Omega Oil Philosophy posters, each with its long line of geese winding down the way toward the reader and each poster carrying a pithy saying. The one I quote read—"Don't inquire into a hungry man's history! Give him something to eat!" You all see the point. I submit the question—have we educators not been a bit too inquisitive recently as to the measure of the progress of our pupils and perhaps somewhat negligent of our duty in connection with inspiring them to dig in and thus make real progress?

I would not like to be regarded as unprogressive in these matters, but I have no objection to being considered as conservative. My thought is this. Is it not time we were putting the new so-called "science" of educational measurements in its proper place? Should we not attempt to view it in its proper perspective? We should give it due credit for the real progress that it has made. A number of most ingenious psychological tests of intelligence have resulted from the labors of workers in that field. May I suggest, however, that experienced teachers can usually estimate rather closely the "I. Qs." of pupils with whom they have been working for a time? It is with the newcomer that the intelligence test is most useful. Even here the results must be "taken with a grain of salt." I recall a case in point. A certain pupil was graded very low after one of the conventional intelligence tests. Later, on being tested in another and very much larger school, the pupil ranked first among several thousand pupils. Investigation showed that on the occasion of the previous test the pupil had needed to go to the toilet, but, on raising the hand, had been told by the teacher that no questions could be answered until the test was over. The I. Q. number that resulted can be imagined. On that occasion it was the teacher's I. Q. that needed investigation.

We must consider, too, that the *character* factor counts in educational results as well as the intelligence quotient. Often our "failures" are of high intelligence but of low moral purpose. Weak wills may be yoked to high intelligence. Is it not true that much of our energy as teachers should be expended in trying to stimulate our pupils to greater effort? Does not *inspiration* often go further than *examination?* Our friends of the educational yardsticks have avoided these intangibles. They have stuck very largely to the *informational* side of *knowing*. For *feeling* and *willing* they have no gages. Yet most of the influences of the great teacher are probably exerted through his pupil's *feelings* stirring their *wills* to action.

Shall we not then recognize the relatively secondary character of the subject-matter which we teach; and apply ourselves to *educating* boys and girls, young men and young women? And if we are to do well at this we cannot afford to spend too much time using artificial and ad-

mittedly not altogether dependable methods of measuring achievement in the memorizing of facts. In the light of the foregoing premises, how unwise it is to conclude, as did one enthusiast in educational measurements, that since certain pupils who had had no chemistry did better on a test than certain others who had taken one semester of chemistry, those pupils who had had no formal instruction should be put at once into the second semester's work. Shades of all educators of all past ages! Did not the most valuable part of the semester's work lie in the experiences of laboratory and of class-room and in the intercourse between pupil and pupil and between pupil and teacher? Were not all of those pupils going on into life and fewer than five per cent into chemistry?

You who know me so well will not be misled into thinking that I am not an admirer of scholarship. Fine scholarship is an admirable, an excellent thing. It may be had, however, only by those who, having high native intelligence are taught to make good and efficient use of it in acquiring, classifying, storing, and learning how to apply knowledge. The teacher who can stimulate and guide the learner to do these things, especially the latter, has his hands full without making very large use of objective tests. His examinations will have to be largely in the nature of teaching exercises calculated to lead his pupils to attempt to apply in new situations the essential facts that they should have previously learned. It is only by repeatedly encouraging her fledgelings to try their wings that the mother bird teaches her young to fly.

In fairness to some of the more recent tests, some success has been attained in bringing in questions that give the pupil a chance to use his ability to apply his knowledge. It is, however, admittedly a more difficult type of question to prepare than the questions that deal with mere information, and few "thought questions" appear in most tests.

By way of constructive criticism, may I suggest that instead of spending an undue amount of time, as I suspect some teachers are doing, upon what is considered by its devotees, scientific testing, we should devote much time and energy to an attempt to discover how we may more effectively arouse the interest of our students in the subjects we are teaching. To do this we must study the present interests of our boys and girls and make contacts with them. We should also study the tactics of all great teachers in all times and in other countries and learn of them. The well-considered opinions of present-day educators should be respected, studied, weighed, and suitable use should be made of them. Although our modern school of scientific testers scoffs at mere opinion let us remember that great businesses are successfully run by boards of directors—men of experience, who may make due use of statistical evidence in arriving at their conclusions, but who rely finally on their own judgment in making their decisions. So, too, should we teachers make due use of the various

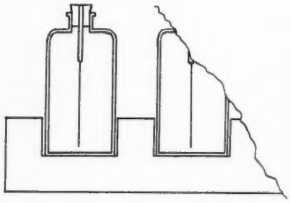
methods of testing results now available to us, but let us not fail to be governed by our common sense.

As the irate mother, whose boy had been beaten by the teacher, wrote, "Don't lick him! Larn him!" so I say, "Don't test him! Teach him!"

FLAME TESTS

JOSEPH I. OSER, SIMON GRATZ HIGH SCHOOL, PHILADELPHIA, PENNSYLVANIA

In showing the characteristic colors imparted to flames by salts of various metals, it is time-wasting and annoying to have to clean carefully the platinum wire before each test.



One will save time and get more satisfactory results by making a set of bottles each containing a solution of the pure salt to be tested. Replace the ordinary glass stopper of each bottle with a singly perforated rubber stopper. Through the perforation passes a glass tube or rod, in one end of which is sealed a platinum wire. Thus each platinum wire is used with but one solution and does not become contaminated.

Small reagent bottles (two-inch diameter) may be used and placed in holes drilled one inch deep in a block of wood two inches thick. Thus all the solutions needed are conveniently kept together.

For high-school work I find it satisfactory to show six flame tests—with the chlorides of sodium, potassium, lithium, calcium, strontium, and barium.

"Poor Risk" Students Take Course in How to Get through College. Hope for students who are anxious to go through college even though they are labeled by intelligence tests and high-school grades as "poor college risks" is held out as a result of an experiment in intensive training conducted by Dr. Edward S. Jones, professor of psychology at the University of Buffalo.

Dr. Jones took thirty-two high-school graduates who ranked with the lowest two-fifths of their high-school class and gave them almost a month's course to fit them to compete with other college students. They were taught how to take notes from lectures. They were drilled in rapid reading, and tested to see how much of the material read they understood and remembered. They practiced writing compositions and doing mathematical problems and they heard lectures on habits, attentiveness, mental hygiene, memorizing, and choosing a vocation.

Students who went into training for freshman work made distinctly better records during the first two semesters than the same type of students who did not have the preliminary training, Dr. Jones states, in reporting his experiment in the *Journal of Personnel Research*.

At Thanksgiving time only eight of the thirty-two were warned of failure in two subjects, and at the end of the second semester the marks of the group averaged higher than in the first semester. This is considered particularly encouraging, since Dr. Jones states that "with other students there has been found no significant difference in average marks from one semester to the next."

All but one of the students who had the pre-college coaching course improved in ratings on intelligence tests, Dr. Jones reports. This is attributed largely to their intensive practice in rapid reading, in understanding directions, focusing attention, and in setting about work in an orderly manner.—*Science Service*

CONSTRUCTION AND USE OF MODELS IN CHEMISTRY

I. W. WADE, NEW YORK UNIVERSITY, NEW YORK CITY

The widespread interest in the structure of matter has created a demand for an adequate method of presenting the new theories and concepts. The use of models to illustrate structure is not new; van't Hoff's work on isomers and stereoisomers was made concrete by the use of them. But to the average teacher the high cost of models forces him to one of two alternatives: to teach as best he may without the use of them, or to construct his own models. The purpose of the present paper is to outline briefly the materials and means of construction and to suggest some of the many ways in which models may aid in the presentation of new and difficult theories.

Materials and Construction

The materials selected must be governed somewhat by the use to be made of the finished product. The conventional system of balls and wires is used. For atomic and molecular models this system has found wide application. For the balls many different materials have been tried. Cork balls are relatively cheap, but they are too soft for accurate boring with drills and will not stand much service or handling. Sir William Bragg[1] has found wax balls of value. He states that "balls representing the atoms may be made of hard dentists' wax, which softens in boiling water, and can then be pressed into proper shape in metal molds made for the purpose". . ."the spherical mold is made in two halves; and it is convenient to mount them in the lathe, one on the head and one on the back center. Small balls harden at once, and can be made very quickly; larger balls must be left a little while in the mold. The hard balls can be drilled without becoming softened and deformed by the heat generated in drilling." But this wax is rather costly and the molds are hard to make. Composition materials or synthetic plastics offer excellent material for the model maker, but the cost is often prohibitive. After trials of many different substances, the author has selected rubber as having the most advantages. Soft rubber balls of nearly any size and color may be secured from the Hodgman Rubber Company of Tuckahoe, New York, or may be bought for as little as a cent each in any department store. The sizes selected by the writer were one-half, three-fourths, and one inch in diameter. Ordinary galvanized wire of appropriate size will meet the need of connections for lattice or crystal structures and phonograph needles or dissecting needles will serve as good connectors for closely packed models. The holes for the connecting wires, in using rubber balls, are not drilled, but are made with a large dissection needle or a

[1] Sir William Bragg, "Concerning the Nature of Things," Harper and Brothers, New York, 1925.

carpenter's punch a trifle smaller than the wire to be used. An excellent device for constructing models of tetrahedral arrangement in order to have the wires at an angle of 109.5 degrees is described by W. H. Dore.[2] Golf balls have been used by G. O. Higley[3] but they are very expensive and do not present to the model maker more than one size from which to select and offer many difficulties in drilling. In making models of the periodic system, such as suggested by Dr. Henry D. Hubbard, the rubber

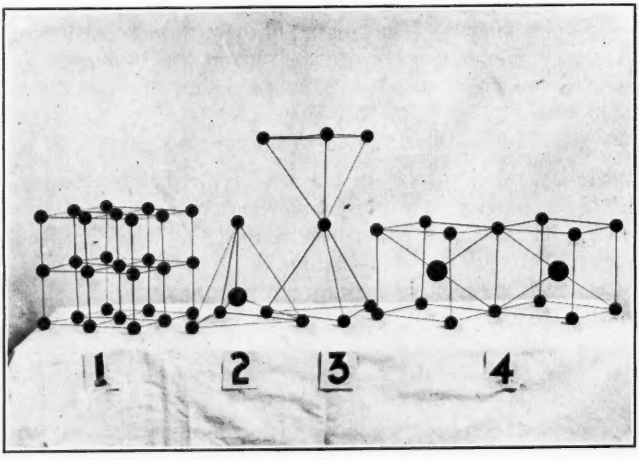


FIG. 1.—A GROUP OF MODELS MADE BY THE AUTHOR AT A TOTAL COST OF $0.80, EXCLUSIVE OF LABOR

1. A model representing the space relations of the atoms of sodium and chlorine in rock salt, but may illustrate any cubic-lattice structure.
2. Tetrahedral carbon atom, or molecule of methane, etc.
3. Model used to illustrate stereoisomerism of tartaric acid, etc.
4. Two atoms of fluorine are shown united by sharing two electrons in the L orbit; other electrons are omitted for clearness.

balls may have the wires running entirely through them to facilitate adjustment.

Advantages of Rubber as a Structural Material

The special advantages offered by having the balls made of rubber were found to be: (1) The wires can be pushed into the balls to any depth in order to make the distances between the balls the same. (2) The wires have no tendency to slip either in or out because the rubber is elastic and holds them firm. (3) The wires may be removed from the rubber without leaving a noticeable hole, thus making changes in structure

[2] W. H. Dore, THIS JOURNAL, **3**, 319–23 (March, 1926).

[3] G. O. Higley, *Ibid.*, **2**, 499–500 (June, 1925).

easy and always finished in appearance. (4) The models can be twisted to illustrate strain in crystal structures or to show the formation of a double bond by folding the two tetrahedra in Figure 1, Model 3, upon themselves. Upon releasing the stress the model assumes its original shape. (5) Having the balls of different size is better than painting them to indicate different atoms or units, for in the first case the same model may be used to illustrate several different compounds. In Figure 1, Model 2 may be used to show relation of the electrons in a carbon atom, or a molecule of methane gas or of carbon tetrachloride.

Use of Models as Teaching Aids

I. *In Inorganic Chemistry:* Models built to represent the structure of the atom according to the theory of Lewis[4] are indispensable for teaching valence. The transference or sharing of electrons by two atoms can be illustrated by such models as that of fluorine in Figure 1, Model 4. In this connection the student should be made acquainted with the monograph by Lewis: "Valence and the Structure of Atoms and Molecules." It is often difficult to prove to freshmen that there is a structural difference between the sodium atom and the sodium ion, but models will convey an indelible impression of the true relationship. The writer has attained considerable success in teaching the balancing of oxidation and reduction equations by the use of models. Starting with a simple equation, such as the action of sodium on water:

$$2Na + 2HOH \longrightarrow 2NaOH + H_2$$

a model of the sodium atom and one of the hydrogen ion are used to show the transference of one electron from the sodium to the hydrogen. In teaching the periodic system, the author has found the "Periodic Chart of the Atoms," compiled by Dr. H. D. Hubbard, to be very clear to the students when used in connection with model displays. The ability of any given element to exhibit either a positive or negative valence in accordance with the number of electrons in the outer orbit is easily demonstrated. Other applications of models to teaching the periodic system are: planetary concept of the atom (Fig. 1, Model 2), calculation of electrons in the nucleus, atomic weights and atomic numbers, crystal type of the elements, end-atom cubic structure, orbit-type transitions, meaning of the terms: orbit, electron, and proton. Copies of W. H. Bragg's "Concerning the Nature of Things" and of Millikan's "The Electron" should be available for student use.

In the explanation of ionization, electrolysis, and radio-activity the models will find many applications. Other uses in general chemistry will quickly suggest themselves to the alert teacher and the interested pupil.

[4] G. N. Lewis, *J. Am. Chem. Soc.*, **38**, 762 (1916).

II. *In Organic Chemistry:* The application of models to the elucidation of theory found its first success in the field of organic chemistry. Kekule's work gave rise ultimately to van't Hoff's statement of the theory of stereoisomerism.[5] Models are applicable to teaching all the following: valence,[6] proof of the structure of methane, impossibility of isomers of the type CH_2X_2 (where X is univalent constituent), structural formulas in general, double and triple bond formation, structural rearrangements; theory of the benzene molecule, steric influences, etc.[7]

III. *In Physical Chemistry:* Physical chemistry offers theories which the use of models will greatly clarify: the birth and growth of crystals, crystallographic form and chemical composition, atomic theories, electrolytic dissociation phenomena and composition, and chemical activity.

IV. *In Colloid Chemistry:* The rapid growth of colloid chemistry has been due to the addition of new and important theories to the physics and chemistry of dispersed systems. Models are helpful in explaining the relationship of particles and the dispersion medium, surface tension phenomena, segregation of sols into two layers, spreading of films on water, theory of protection, polar and non-polar molecules, interfacial film composition, theories of adsorption, etc.

Models as Student Projects

The construction of models offers to the teacher with "advanced" students a rare opportunity to turn their interest into something worthwhile. The students can be allowed to make models as an extra activity or as regular assigned work and the finished products will not only impress the theory which they explain on the mind of the student, but will add fresh and additional structures to the teaching collection.

[5] Cohen, "Organic Chemistry for Advanced Students," Edward Arnold, London, 1924. Part II: "Structure," 4th edition.

[6] W. A. Noyes, "Organic Chemistry," Henry Holt and Co., New York, 1926, p. 4.

[7] Richter, "Organic Chemistry," P. Blakiston's Sons and Co., Philadelphia, 1925, Volumes I and II.

Isolates New Germ from Meningitis Case. A new germ isolated from a fatal case of meningitis was recently reported to the Society of American Bacteriologists by Dr. Edna G. Jackson of the Henry Ford Hospital at Detroit, Mich.

Though spinal meningitis is caused by a characteristic small round microbe of the type known as a coccus, this new rod-shaped bacillus was isolated both from the spinal fluid and from the blood of a severe case.

"It is virulent for laboratory animals," declared Dr. Jackson, "and this virulence has been retained after several months' growth upon artificial media."—*Science Service*

MOVING AMALGAM ELECTRODES IN CLASS WORK

J. C. MICHALEK AND T. E. PHIPPS, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

That alkali metal amalgam electrodes are the most reproducible of all electrodes has been shown by the work of G. N. Lewis[1,2,3,4] and others.[5,6] The difficulty of handling amalgams of reactive metals has no doubt prevented a widespread use in class work of these otherwise extremely satisfactory electrodes. In this article a relatively simple vessel of the moving amalgam type, adapted to class work, is described, and it is shown that with a simplified technic the measurement of the electrode potential of sodium is not beyond the ability of a university class in electrochemistry.

A Simplified Moving Amalgam Electrode Vessel[7]

The electrode vessel, consisting of a solution reservoir *A*, chamber *C*, calomel electrode *E*, trap *F*, and stopcocks *G* and *H*, is made of Pyrex glass. The amalgam electrode, made of soda glass, consists of a glass-stoppered reservoir *B*, a platinum wire sealed in at *D*, a capillary dropper *R*, and a rubber stopper *M*. An ordinary filter flask *I*, with rubber outlet tube at *J*, serves as a reservoir for spent solution and amalgam. The apparatus is clamped to a brass rod or ringstand at *O* and at *P*.

In operation, the first step consists of filling the side arm of the calomel electrode with mercury. Mercury and calomel paste, equilibrated with the solution to be used, are then introduced into *E* (Fig. 1). With *H* closed, *C* and *E* are then filled, through *G*, with the solution. *E* is then stoppered, *G* is closed, and *A* is filled. To fill the amalgam reservoir *B*, the capillary tip of the dropper is introduced below the surface of the amalgam in a supply bottle and suction is applied. This method of filling avoids trapping air below the stopcock *N*, with the resultant breaking of contact between amalgam and platinum wire. If the amalgam is reactive, it is best kept under toluene (dried by sodium) in the supply bottle, and a protective toluene layer is kept in reservoir *B*. The amalgam electrode is then mounted in *C*, stopcock *G* is opened, and stopper *M* is pressed firmly into place. Stopcock *H* is opened, and the apparatus is immersed in the thermostat to the level *K*.

When the temperature is constant, *N* is opened to permit drops of amalgam to pass *C* at a slow rate, say five drops per minute. The best rate

[1] Lewis and Kraus, *J. Am. Chem. Soc.*, **32,** 1459 (1910).

[2] Lewis and Keyes, *Ibid.*, **34,** 119 (1912).

[3] Lewis and Keyes, *Ibid.*, **35,** 340 (1913).

[4] Lewis and Argo, *Ibid.*, **37,** 1983 (1915).

[5] Allmand and Polack, *J. Chem. Soc.*, **115,** 1020 (1919).

[6] Richards and Conant, *J. Am. Chem. Soc.*, **44,** 601 (1922).

[7] Vessels of similar construction are described by Lewis, McInnes and Parker, and others.

must be determined in each case as it depends on the concentration of the solution and the composition of the amalgam used.[8] Stopcock G is opened enough to allow solution to drip through the tip Q at a slow rate. This rate must be greater for dilute than for concentrated solutions, and the best rate must be determined for each set of conditions. Small copper wire (No. 32 B. & S. approximately) is most convenient for making a twist connection from the platinum loop D to the potentiometer.

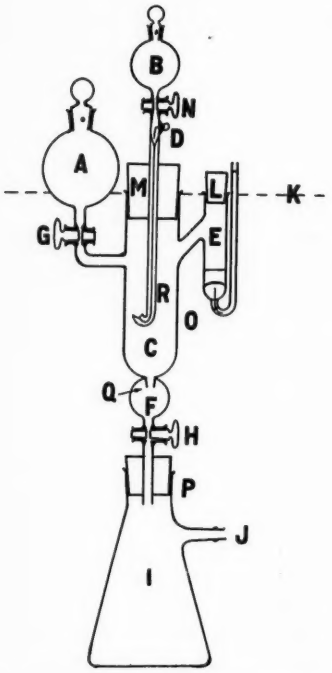


FIG. 1.—Moving Amalgam Electrode.

With 1 molal NaCl solution, and sodium amalgams ranging from 0.1 to 0.4 per cent sodium, e. m. fs. will be found constant to better than 0.1 millivolt, and they are independent within wide limits of the rates of flow of amalgam or solution—unless, as occasionally happens, a reaction is plainly visible on the surface of the drop of amalgam. This is seen as a gas evolution at a single point on the surface, and is probably due to a catalytic impurity in the amalgam. A slight spurt of the amalgam serves to dislodge it. No extreme precautions were taken to remove oxygen from the distilled water used in making up solutions, nor were the solutions protected from the air.

With 0.1 and 0.01 molal NaCl solutions the solution flow must be increased to approximately 20 drops per minute. Even under these conditions the e. m. fs. are not quite as constant as in the more concentrated solutions.

If two different concentrations of electrolyte with the same amalgam concentration are used in the above vessel successively, the difference of the e. m. fs. measured will be equal to the e. m. f. of a "concentration cell without liquid junction" operating between the two concentrations. From this value the ratio of the activities of the electrolyte at the two concentrations can be calculated.

[8] Trap F serves to separate the drops of amalgam from the cell proper and thus prevents troublesome reaction of spent amalgam with the solution. The tip Q should be about 3 mm. inside diameter so as to allow the amalgam to drop through immediately; this diameter of tip prevents regurgitation of air back into C.

In the following paragraphs another class experiment involving the above moving amalgam vessel, is described.

Determination of the Standard Electrode Potential of Sodium

It is possible with this type of vessel for a class in electrochemistry to carry out the most important step in the determination of the standard electrode potential of sodium, namely, determining the e. m. f. against

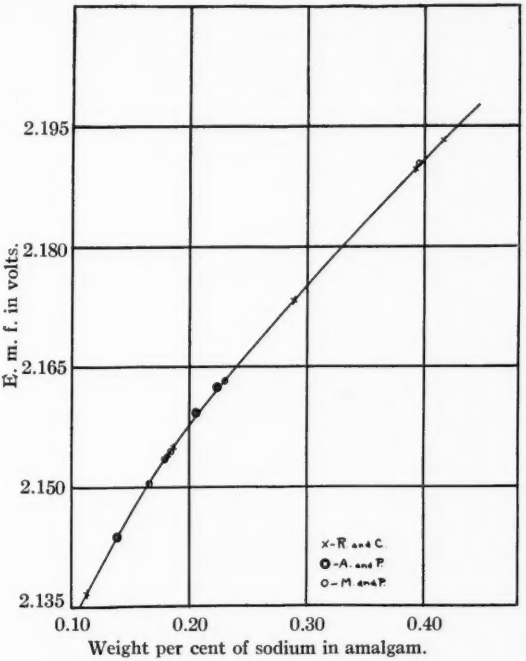


FIG. 2.—E. m. f. of the cell, Na (amalgam, *a* %), NaCl (1 *M*), HgCl, Hg, as a function of the per cent of sodium in the amalgam.

calomel of a sodium amalgam in an aqueous solution. To complete the determination, Lewis and Kraus[1] measured the e. m. f. of the same sodium amalgam against metallic sodium in a solution of NaI in anhydrous ethylamine. In order for the class to use in their calculations Lewis and Kraus' value for the ethylamine cell, it would be necessary to use in the moving amalgam experiment the *same* composition of amalgam as that used by Lewis and Kraus. It would be very awkward to attempt the use in class work of an amalgam of specified composition. For the con-

venience of the class we have, therefore, recalculated and plotted the data of Allmand and Polack,[5] Lewis and Kraus,[1] and Richards and Conant,[6] to the axes: e. m. f. of the cell Na (amalgam, *a*), NaCl (1 *M*), HgCl, Hg, against weight per cent of sodium in the amalgam. In addition to these values we have determined several points on the curve independently. These data appear in Table I and are plotted in Figure 2. The general agreement is excellent.

A description of the experiment follows. The instructor makes up for class use several different sodium amalgams of random composition between the limits, 0.12 per cent and 0.45 per cent.[9] The student measures the e. m. f. of an assigned amalgam against calomel in a 1 *M* NaCl solution. He analyzes the amalgam, and reports the composition of the amalgam and the e. m. f. of the cell to the instructor. The instructor observes from the plot (Fig. 2) the discrepancy, if any, between the reported e. m. f. and that read from the plot for the alleged composition. If the discrepancy is great, the student may be required to repeat the measurement and the analysis until satisfactory agreement is obtained. Then from the plot the difference between the ordinate of the experimental amalgam and that of the reference amalgam can be read off at once. Having transposed his observed e. m. f. to the basis of the reference amalgam, the student adds to this value the e. m. f. of the ethylamine cell. This gives the e. m. f. of the cell, Na(*s*), NaCl(1 *M*), HgCl, Hg. To correct for the calomel electrode, he subtracts 0.2700 volt, and to reduce to unit activity he subtracts 0.0220 volt.

An independent measurement of the ethylamine cell by one of the authors gave 0.8510 volt at 25°C. for amalgam composition, 0.1795 per cent by weight. The e. m. f. of the cell Na (amalgam, 0.1795%), NaCl (1 *M*), HgCl, Hg, was found to be 2.1535 volts. Reducing to standard conditions, as indicated above,

$$2.1535 + 0.8510 - 0.2700 - 0.0220 = 2.7125,$$

we arrive at a value identical with that of Lewis and Kraus for the standard electrode potential of the sodium electrode, and this determination constitutes an independent check upon that value.

The analysis of amalgams causes some trouble to students. The following procedure is recommended. To take amalgam samples all stopcocks are closed, the dropping electrode is removed from the vessel, the adhering solution is removed from the tip, and the amalgam is allowed to drop into

[9] The dilute amalgam is prepared by adding small pieces of sodium to the mercury. Oxidation is prevented by a layer of toluene on the mercury. Each piece of sodium should react or be made to react by pushing it under the surface of the mercury with a stirring rod. Occasionally the reaction is violent enough to set fire to the toluene, and for this reason it is best to use an Erlenmeyer flask so that by stoppering the flask the fire can be extinguished easily.

weighed Erlenmeyer flasks or weighing bottles. A fifteen-gram sample is sufficient for most of the amalgam compositions. Weighings are made to the nearest centigram. The electrode is then replaced in the vessel and the e. m. f. is taken again. The reading should be the same as before to 0.1 millivolt. The samples are titrated with 0.1 *N* HCl, with methyl red as indicator. The most effective method of decomposing the amalgam completely is to "swish" it at a rapid rate, avoiding any large momentary

TABLE I

E. M. F. COMPOSITION DATA FOR SODIUM AMALGAM ELECTRODES

Weight per cent Na in amalgam	E. m. f. in 1 *M* NaCl against calomel	Investigator	Legend on plot
0.206	2.1593	Allmand and Polack	
0.2235	2.1624	Allmand and Polack	⊙
0.1393	2.1438	Allmand and Polack	
0.166	2.1504	Allmand and Polack	
0.1815	2 1539	Richards and Conant	
0.1862	2.1548	Richards and Conant	
0.2895	2.1732	Richards and Conant	×
0.393	2.1897	Richards and Conant	
0.416	2.1932	Richards and Conant	
0.1842	2.1543	Michalek and Phipps	
0.2311	2.1632	Michalek and Phipps	
0.1125	2.1367	Michalek and Phipps	⊙
0.395	2.1904	Michalek and Phipps	
0.179	2.1535	Michalek and Phipps	

excess of acid. The addition of platinum scrap did not hasten the decomposition.

It is apparent at once that the data of Table I may be used as the basis of an extremely accurate e. m. f. method of analysis of sodium amalgams, and the experiment can be varied, at the discretion of the instructor, to emphasize the possibility of such an analytical procedure.

The experiment as outlined above has been performed by an electrochemistry class for the past two years, and in nearly all cases the individual values for the potential of the sodium electrode have fallen within a few tenths of a millivolt of the correct value.

Pneumatic Tubes Transport German Steel Samples. Red-hot samples of steel are shot through pneumatic tubes recently installed between a steel mill and its testing laboratory. This novel method of conveyance was installed in order to allow the laboratory to be located away from the smoke and dirt of the mill itself.—*Science Service*

A TOPICAL BIBLIOGRAPHY FOR THE AMERICAN CHEMICAL SOCIETY PRIZE ESSAY CONTEST*

I. W. WADE, NEW YORK UNIVERSITY, NEW YORK CITY

During the past two years the author has had occasion to assist students in obtaining references for the American Chemical Society Prize Essay Contest. It was thought that this list might prove valuable to both students and teachers and with this in mind, the following bibliography was revised and enlarged.

Students should not try to read entirely any book. It is far better to examine each book with regard to the preface, table of contents, chapter headings, and index in order to find relevant material. Short notes, comments, or quotations should be made on uniform filing cards or loose leaves in order that they may be shifted when the material is being organized. Unless a student is particularly interested in one of the subjects, it is recommended that a short essay be written on each of the six topics in order to discover which can be treated best. In the author's classes last year the students submitted one essay each week for six weeks preceding the closing date of the contest. At the end of this time, the best essay of the six was selected by the teacher and the student in conference. This paper was then revised or entirely rewritten with additional material before being submitted for the elimination contest.

For additional information concerning the contest write to Mr. Paul R. Smith, 85 Beaver Street, New York City.

I. The Relation of Chemistry to Health and Disease:

A. C. S. Committee: *Future Independence and Progress of American Medicine in the Age of Chemistry.* Chemical Foundation, Inc.
Vallery-Radot: *Life of Pasteur.* Doubleday, Page.
Paul de Kruif: *Microbe Hunters.* Harcourt Brace.
Fuller: *The Story of Drugs.* Century.
Mendel: *Nutrition: The Chemistry of Life.* Century.
Lester: *Readings in Science.* Houghton Mifflin Co.
Sherman: *Chemistry of Food and Nutrition.* Macmillan.
Pryde: *Recent Advances in Bio-chemistry.* Churchill.
McCollom: *Medical Organic Chemistry.* Macmillan.
Plimmer and Plimmer: *Vitamins and the Choice of Foods.* Longmans.
Journal of American Chemical Society, **48**, 153 (1926).

II. The Relation of Chemistry to the Enrichment of Life:

Slosson: *Creative Chemistry.* Century.
Slosson: *Chats on Science.* Century.
Foster: *The Romance of Chemistry.* Century.
Howe: *Chemistry and the World's Work.* Van Nostrand.

* This manuscript was received too late to be of great value in the preparation of this year's essays. It is hoped, however, that teachers will note it for future reference.

Cushman: *Chemistry and Civilization.* Dutton.
Findlay: *Chemistry in the Service of Man.* Longmans.
Gregory: *Discovery, The Spirit and Service of Science.* Chemical Foundation, Inc.
Tilden: *Chemical Discovery and Invention in Twentieth Century.* E. P. Dutton & Co
Arrhenius—Leonard: *Chemistry in Modern Life.* Van Nostrand.
Duncan: *The New Knowledge.* Barnes.
Bird: *Modern Science Reader.* Macmillan.
Mills: *The Realities of Modern Science.* Macmillan.

III. The Relation of Chemistry to Agriculture or Forestry:

Chamberlain: *Chemistry in Agriculture.* Chemical Foundation, Inc.
Slosson: *Creative Chemistry.* Century.
Chamberlain: *Organic Agricultural Chemistry.* Macmillan.
Snyder: *Chemistry of Plant and Animal Life.* Macmillan.
Willaman: *Vocational Chemistry.* Lippincott.
Thatcher: *Chemistry of Plant Life.* McGraw-Hill.
Lester: *Readings in Science.* Houghton Mifflin.
Stoddart: *Chemistry of Agriculture.* Lea & Febiger.
Pack: *The School Book of Forestry.* American Tree Assn.
Tottingham and Ince: *Chemistry of the Farm and Home.* Webb.
Department of Agriculture: Yearbook and Bulletins of the Department.
Department of Agriculture. *Journal of Agricultural Research.*

IV. The Relation of Chemistry to National Defense:

Fries and West: *Chemical Warfare.* McGraw-Hill.
Haldane: *Callinicus: A Defense of Chemical Warfare.* Dutton.
Lefebure: *The Riddle of the Rhine.* Chemical Foundation, Inc.
Vedder: *Medical Aspects of Chemical Warfare.* Williams & Wilkins.
Howe: *Chemistry in the World's Work.* Van Nostrand.
Armstrong: *Chemistry in the Twentieth Century.* Macmillan.
Slosson: *Creative Chemistry.* Century.
See files of the *Forum, Current History,* and *World's Work.*

V. The Relation of Chemistry to the Home:

Berry: *Chemistry Applied to Home and Community.* Lippincott.
Howe and Turner: *Chemistry and the Home.* Scribner.
Garard: *Applied Chemistry.* Macmillan.
Snell: *Elementary Household Chemistry.* Macmillan.
Vulté: *Household Chemistry.* Chemical Publishing Co.
Tinler and Masters: *Applied Chemistry.* (2 volumes) Lockwood.
Bird: *Modern Science Reader.* Macmillan.
Brownlee: *Chemistry of Common Things.* Allyn & Bacon.
Findlay: *Chemistry in the Service of Man.* Longmans.
Tottingham and Ince: *Chemistry of the Farm and Home.* Webb.
See files of *Journal of Home Economics, Popular Science Monthly, Scientific American,* etc.

VI. The Relation of Chemistry to the Development of an Industry or a Resource of the United States:

Howe: *Chemistry in Industry.* (2 volumes) Chemical Foundation, Inc.
Farrell: *What Price Progress?* Chemical Foundation, Inc.

Farnham and others: *Profitable Science in Industry.* Macmillan.
Flinn: *Popular Research Narratives.* (2 vol.) Williams & Wilkins.
Bruttini: *Uses of Waste Materials.* King and Sons (London).
Baskerville: *Municipal Chemistry.* McGraw-Hill.
Duncan: *The Chemistry of Commerce.* Harper.
Rogers: *Industrial Chemistry.* Van Nostrand.
Benson: *Industrial Chemistry.* Macmillan.
Tilden: *Chemical Discovery and Invention in the Twentieth Century.* E. P. Dutton & Co.
Gruener: *Chemistry.* Harper.
Department of Interior: Bulletins of Bureau of Commerce.
Historian's History of the World, Volume 26, Part II, "These Eventful Years." Publishers: Encyclopedia Britannica.

SECOND INSTITUTE OF CHEMISTRY

The Second Session of the Institute of Chemistry of the American Chemical Society will be held in Evanston, Illinois, from July 23 to August 18, 1928. Every effort is being made to arrange the lectures and conferences of the Institute in such a way as to offer a unique service to chemists, both industrial and academic. Suggestions will be gladly received by members of the Committee or by the Executive Secretary. The Committee in charge of the Institute consists of N. E. Gordon, Chairman of the A. C. S. Committee on Chemical Education, University of Maryland; B. S. Hopkins, Chairman of the Division of Chemical Education, A. C. S., University of Illinois; H. E. Howe, Editor, *Industrial and Engineering Chemistry* and Head of the A. C. S. News Service, Washington, D. C.; C. E. K. Mees, Eastman Kodak Company; S. W. Parr, President of the American Chemical Society, University of Illinois; C. L. Parsons, Secretary of the American Chemical Society, Washington, D. C.; C. M. A. Stine, E. I. du Pont de Nemours & Company; G. L. Wendt, The Pennsylvania State College; F. C. Whitmore, National Research Council; W. R. Whitney, General Electric Company; and F. W. Willard, Western Electric Company. The Executive Secretary will be C. D. Hurd, Northwestern University, Evanston, Illinois.

Following is a tentative list of subjects for conferences for the A. C. S. Institute of Chemistry which will be held in Evanston, Illinois, from July 23 to August 18, 1928. Suggestions and criticisms should be sent to F. C. Whitmore, National Research Council, Washington, D. C. There will be 28 conferences, arranged at times when two and a half hours will be available for each. Thus, several conferences can be devoted to the same subject if it seems important enough to warrant this.

One group of subjects will deal with the help which chemistry can give for the better utilization of raw materials: (1) Agricultural products; (2) Coal; (3) Petroleum; (4) Metals; (5) Animal Products. Obviously, only certain aspects of these subjects can be covered. In addition, certain miscellaneous subjects have been suggested for conferences: (6) Chemotherapy; (7) Disposal of municipal wastes; (8) Rubber; (9) Science and national defense; (10) Chemistry of life processes; (11) Synthetic "raw" materials; (12) Antioxidants; (13) Cellulose.

Suggestions are needed regarding the special phases of these topics which can best be treated and regarding the best men to lead the discussions. In no sense will the conferences be limited merely to the subjects listed above. Suggestions of other subjects are earnestly sought.

THE VOLUMETRIC DETERMINATION OF CHLORIDE

WM. B. MELDRUM AND J. C. FORBES, HAVERFORD COLLEGE, HAVERFORD, PENNSYLVANIA

In the teaching of quantitative analysis to students without experience in this branch of chemistry the determination of chlorine, both gravimetrically and volumetrically in the same sample, is a useful pedagogical device. The interest of the student is aroused by the check analyses obtained by such widely different methods and at the same time he is introduced to the two general procedures which probably will weigh most heavily in the course. It is highly desirable, because of the student's inexperience, that the procedure be simple and straightforward and that he may obtain results that do check without too many repetitions. Repetition of analyses in the first few weeks of the course may be counted upon, as a rule, to kill interest pretty effectively.

From this point of view the gravimetric determination of chlorine, using preferably the Gooch crucible, is as satisfactory as any useful method could be expected to be. The volumetric method has not met the specifications so well. The Volhard method, the one generally included in laboratory manuals, involves too many operations and is not readily understood by the beginner, and the results, at least so far as the experience of the authors indicates, are poor. The Mohr method, though simple, yields results that are only approximately correct at best. Nevertheless, the authors were convinced that the Mohr method was the only one usable in the early weeks of the course and so attempted to modify it in such a way that the main errors might be eliminated to as large an extent as practicable. The results of this effort were so satisfactory that the publication of the modified procedure was considered worthwhile. The working out of the procedure given in this paper solved what has been a serious pedagogical problem in this laboratory.

Three sources of error stand out most prominently: (1) Temperature effect on the solubility of silver chromate; (2) lack of sensitiveness of the end-point due to too great acidity or alkalinity of the solution; (3) adsorption of soluble chloride by the precipitated silver chloride.

The necessity of titrating in the cold and of adjusting the p_H of the solution have been emphasized in modern texts on quantitative analysis.[1] Even granting that these precautions are observed it has been recommended that Mohr's method be used only for determining small amounts of chlorine, as in water analysis.[2] Attempts to eliminate errors due to the third-mentioned source do not seem to have been made and it seemed very

[1] Fales, "Inorganic Quantitative Analysis," The Century Co., **1925,** p. 175. Blasdale, "Principles of Quantitative Analysis," Van Nostrand, **1917,** p. 260.

[2] Scott, "Standard Methods of Chemical Analysis," Van Nostrand, **1927,** p. 126. Treadwell and Hall, "Analytical Chemistry," John Wiley & Sons, Inc., Vol. II, p. 545.

probable that it might account for the limitation of the method to small amounts of chlorine. The precipitated silver chloride comes down initially in a finely divided condition and does not coagulate until the end-point is very nearly reached—and does not do so completely then. Adsorption should then be expected. When provision was made to eliminate the error due to this cause the results were definitely better and the necessity to repeat the determination due to discordance of results has become rare.

The procedure finally adopted was as follows:

Dry the chloride material for one hour at about 140°C. Cool in desiccator and weigh samples of about 0.4 gram into 200 cc. Erlenmeyer flasks and dissolve in about 75 cc. water. Add 1 drop methyl orange solution and dilute nitric acid until the solution turns pink. Now add 1% sodium bicarbonate solution until the color turns to yellow and then 1 cc. in excess. Add 5 drops 0.1 *M* potassium chromate solution (free from chloride) and titrate with standard silver nitrate solution, about 0.2 *N*, to a *faint* end-point. Boil for five minutes; cool in ice water to 20°C. or lower. Finally titrate with the standard silver nitrate to a faint end-point.

The silver nitrate solution should be standardized against sodium or potassium chloride of known chloride content using the same procedure as above.

I. STANDARDIZATION OF SILVER NITRATE SOLUTIONS

Experimenter	Wt. NaCl	Vol. $AgNO_3$ soln.	Normality
A	0.2312 g.	23.27 cc.	0.1699
	0.3104	31.25	0.1699
	0.2763	27.81	0.1699
			Average 0.1699
B	0.3120	26.77	0.1993
	0.5537	47.53	0.1993
	0.3190	27.47	0.1986
			Average 0.1991
C	0.1946	21.22	0.1568
	0.1970	21.48	0.1568
	0.2151	23.39	0.1572
			Average 0.1569

The first end-point reached is not permanent; if the flask be allowed to stand in the dark for half an hour the color due to the precipitated silver chromate fades out completely. The second end-point is permanent, indicating a real excess of silver nitrate. The amount to be added to attain the final end-point varies from about 0.5 to 2 drops, equivalent to about 0.03 to 0.12 cc. Other opinions to the contrary notwithstanding, the end-point is very sharp and when near the end-point drops should be

divided. As little as 0.02 cc. makes a distinct difference. It should also be noted that there is no excuse for anyone, even the novice, to go over the end-point even to the extent of a single drop. The gradual change in the color of the precipitate in the region of the added silver nitrate is a sure indication of the proximity to the end-point. The silver nitrate should be added about 1 cc. at a time; at first the color before shaking is a faint salmon pink because of the relatively small proportion of silver

II. ANALYSIS OF MATERIAL FOR SOLUBLE CHLORIDE

Experimenter	Wt. sample	Vol. $AgNO_3$	% Cl	% Cl gravimetric
A	0.3896 g.	21.51 cc.	33.26	33.22
	0.3929	21.68	33.25	33.31
	0.3926	21.66	33.24	33.26
		Average	33.25	33.26
B	0.3619	17.58	33.44	33.31
	0.3715	17.27	33.35	33.29
	0.3702	17.44	33.29	33.36
		Average	33.35	33.32
C	0.3924	23.48	33.33	
	0.4011	24.05	33.39	
	0.3985	23.81	33.29	
		Average	33.34	

chromate; as the titration proceeds and the excess of chloride becomes less the color deepens and as the end-point is approached becomes a distinct red.

These results were obtained by three experimenters independently using different standard solutions, but the same material for analysis. They are not perfect but it is highly probable that they would all be acceptable by an instructor in quantitative analysis. The instructor's analysis (gravimetrically) of the same material showed 33.35% Cl.

Wheat Plants Feed Better in Green-Violet Light. Dr. W. E. Tottingham and H. Lowsma, of the University of Wisconsin, have grown wheat under artificial light, giving different lots of their plants different shares of the spectrum by means of glass color filters. They found that the wheat absorbed nitrate, the cornerstone of protein, most rapidly under the influence of rays of the green-to-violet section of the spectrum of visible light. The longer ultra-violet wave-lengths also encouraged nitrate assimilation, though not to so great a degree, but short-wave ultra-violet rays were of no use in this important process.—*Science Service*

A DIAGNOSTIC STUDY OF STUDENTS' DIFFICULTIES IN CHEMISTRY AND THE EFFECTS OF APPLICATION OF REMEDIAL MEASURES

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For the last few years the writer has been interested in diagnosing the difficulties that high-school pupils encounter in their general chemistry and in the effects produced by the application of remedial measures. The tools used in these investigations have been standardized chemistry tests and new-type chemistry tests of the writer's making. In this particular study, the Powers Chemistry Test, Form B, was used as part of the final examination in June, 1925; as part of the mid-year examination in January, 1926; and as part of the final examination in June, 1927. At the mid-year examination in January, 1927, the writer's home-made test was used because it covered a half year's instruction in chemistry more thoroughly than a standard test.

Each of the examinations has been analyzed according to the following outline: (1) Number of pupils answering each item correctly; (2) per cent of class answering each item correctly; (3) types of errors occurring in writing formulas, naming formulas, writing equations, and the solving of chemical problems. The percentage of errors falling into each of the four above-mentioned classes was also computed in each case. Not only have the results of these examinations in the various classes been compared, but they have also been compared with the findings of S. R. Powers[1] and with the results obtained by Miss Julia C. Bennett[2] in a study of 1470 cases. The Swarthmore High School chemistry classes were then compared as to number of students in each class, mental age, and intelligence quotients.

The remedial measures applied during the school year 1926–1927 are described in part as follows. The first remedial work was tried out at the beginning of the year in problem work. Knowing from former experience that many members of each class are weak in the mechanics of mathematics, the instructor decided to test the members of this year's class on that point. Each year the instructor finds it necessary to develop the metric system. This year, after the class had had practice in solving problems in the metric system, the instructor tested their ability in solving metric problems by giving them numbers with decimals in them. The students were thus tested in the mechanics of decimals without knowing that that was one of the purposes of the test. For those

[1] Powers, S. R.: "A Diagnostic Study of Subject Matter of High-School Chemistry," Columbia University Contributions to Education, 149.

[2] Bennett, J. C.: "A Study of Pupil Errors in Chemistry," *J. Educ. Res.*, **14**, 274–83 (November, 1926).

who failed in the test, carbon copies of various exercises in the metric system were made by the writer. The student who was weak in cubical measurement was given a copy of exercises on that phase of the work. In other words, there were types of exercises for every weakness which had been found in the test. The student who failed on account of decimals received instruction and drill in that weakness. The writer feels that this was time well spent, for both the mid-year and final examination had a low number of mechanical errors. At mid-year, 10.7 per cent of all the problem errors were mechanical ones and of the mechanical ones only 7 per cent occurred in decimals. In the Powers Test, Form B, June, 1925, 8 per cent of all the problem errors were mechanical while in June, 1927, 4 per cent of all the problem errors were mechanical ones.

The chief difficulty in problem work is the fact that the student fails to understand the principle or principles involved. When students fail to solve chemical problems correctly in their tests, these problems are assigned to the individuals concerned as home work. If the student is very weak in problem work, he or she receives aid from the teacher and is given practice work along the line of his or her difficulty. The fact that nearly all the tests are corrected by the students in class and then discussed helps the students to understand their own difficulties. Therefore, homework assignment of problems is sufficient in quite a number of cases. If the section as a whole is weak in certain types of problems, these types are given as a part of the regular assignment.

From the results obtained in 1926 at mid-year, it was observed that the percentage of problems answered correctly was higher than in the case of the 1925 chemistry class at final examination. This no doubt was due to the fact that all types of problems are taught in the first semester and as a result, greater emphasis has been placed on problem work in the first semester than in the second semester. This year, although problem work received greater emphasis in the first semester, more problem work was given as home work in the second semester than in previous years. As a result there was an increase of 10 per cent in correct responses in the June, 1927, problems over the January, 1926, problems.

The chief difficulty in writing formulas has been with valence. Until this year, the students have learned the valences of the elements and radicals by practice exercises in formula writing. It has been the instructor's theory that students will gradually learn the valences of various elements and radicals by use. He found, however, that the students rely on valence tables rather than on their memories. Therefore, this year the students were required to memorize the valences of the elements and the radicals they were using. Later the students were checked on the memorizing by means of short written quizzes. The practice exercises in writing formulas were of the same nature as in other years. The

principle of writing formulas was presented to the class in the same manner as previously. The data show that in the Powers Test, Form B, 19.1 per cent of the 1927 class formulas were wrong while in the 1925 class on the same test 23 per cent of the formulas were wrong. Of the formulas wrong in the 1927 class, 18.5 per cent of the errors occurred in valence while in the 1925 class 39 per cent of the errors in formula writing were due to valence.

In teaching the nomenclature of the formulas this year, the writer placed greater emphasis on the learning of the formula and the name of the principal compound in the series. For example, if the student knows the principle of naming the acids and the salts and that the formula for sulfuric acid is H_2SO_4, he should then be able to write the formulas and also give names to the formulas for the other sulfur acids and salts of that

TABLE I

A SUMMARY OF TABLE VII

PERCENTAGES OF TOTAL NUMBER OF PROBLEM ERRORS

January, 1927

Types of errors	Sections A	Sections B	Sections A and B
Principle	54.6%	41.5%	51.0%
Mechanics	8.3%	17.1%	10.7%
Molecular wt.	2.8%	0.0%	1.9%
Multiplication	1.8%	4.9%	2.7%
Division	0.9%	9.8%	3.4%
Addition	1.8%	2.4%	1.9%
Decimals	0.9%	0.0%	0.7%
Carelessness	2.8%	7.3%	4.0%
Guesses	25.0%	24.4%	24.8%
Omissions	9.2%	10.0%	9.4%
	Section A	Section B	Sections A and B
Total no. of errors	108	41	149
Percentage of problems wrong	69.2	35.0	54.6

series. The same should also be true of the other principal acids. Greater emphasis was placed upon this point the first semester than formerly. As a new compound was studied, questions were asked concerning its formula, the valence of its parts, the principle of naming it, the derivation of its name, and its similarity to other compounds already studied. In other words, the writer took greater pains this year in presenting new topics from as many different angles as possible.

From the study of the work of the 1926 class in equations, it is quite evident that the main difficulties resolve themselves into knowing the products of the reaction, writing the formulas, and balancing the equations. After the subject of equation writing had been taught to and practiced by

the class, the class was tested in its ability to write simple equations. The papers were then corrected, analyzed, and returned to the students. The instructor then prepared carbon copies of exercises in balancing equations, in completing equations where no products were given on the right-hand side of the equation, and in writing entire equations. For those who could not write formulas in the equations, exercises in formula writing were

TABLE II

A COMPARISON OF SWARTHMORE'S DATA WITH THAT OF POWERS

Percentage of Responses Correct in Powers Test, Form B, Part I

No. of question	June, 1927	Jan., 1927	June, 1925	Powers' standard
1	85.7		75.7	81.7
2	95.2	95.2 *C*	97.3	90.1
3	76.2		67.7	82.6
4	42.9		48.6	76.1
5	95.2		97.3	70.6
6	95.2		83.8	74.0
7	95.2	47.6 *C*	94.6	69.4
8	42.9	76.2 *C*	27.0	68.7
9	19.0		54.1	64.0
10	95.2		97.3	60.0
11	80.9	90.5 *C*	72.9	72.4
12	38.1	66.7 *C*	32.4	58.2
13	90.5		70.3	60.9
14	19.0		32.4	51.9
15	47.6		64.9	48.9
16	71.4		32.4	
17	90.5		91.9	42.9
18	47.6		67.7	49.3
19	23.8		8.1	37.4
20	61.9	42.9 *C*	62.2	41.0
21	42.9		54.1	35.8
22	47.6	76.2 *C*	18.9	29.5
23	14.3		13.5	27.4
24	47.6	28.6 *C*	48.6	17.9
25	28.6		43.2	24.7
26	57.1		40.5	22.3
27	4.8		2.7	18.2
28	61.9		59.5	15.1
29	9.5		10.8	14.5
30	9.5		10.8	14.4

prepared. As soon as such a student was capable of writing formulas he was then given work in equation writing. Those weak on any of these points conferred with the teacher one period a week and were given practice material on their weak points. This system was not only used with equations, but with formula writing, nomenclature, and solving problems.

TABLE III

A COMPARISON OF SWARTHMORE'S DATA WITH THAT OF POWERS AND BENNETT

Percentage of Responses Correct in Powers Test, Form B, Part II

No. of question	June, 1927	Jan., 1927	June, 1925	Powers' standard	Bennett's standard	Bennett's upper 401
1	80.9		86.5	87.4	70.0	
2	90.5		91.9	..	..	
3	90.5		86.5	83.3	79.1	
4	95.2		83.8	..	..	
5	100.0		81.1	82.1	76.7	
6	95.2		86.5	70.1	77.4	
7	100.0	76.2	91.9	82.0	..	
8	23.8	(47.6)	8.1	78.3	..	
9	95.2	66.7	89.2	79.3	..	
10	80.9		81.1	66.2	..	
11	80.9		67.7	66.1	..	
12	76.2		86.5	60.6	..	
13	85.7		54.1	69.2	..	
14	80.9		72.9	62.2	69.2	88.6
15	80.9		67.7	59.6	44.3	75.6
16	85.7		70.3	58.6	58.2	
17	76.2		56.8	49.7	27.1	74.6
18	57.1	61.9	27.0	57.2	..	
19	28.6	(47.6)	10.8	54.0	..	
20	61.9	38.1	18.9	47.0	..	
21	71.4		21.6	50.4	..	
22	66.7		62.2	46.6	..	
23	23.8		8.1	43.5	..	
24	42.9		35.1	39.2	..	
25	9.5		0.0	34.0	..	
26	52.4		56.8	30.7	49.7	
27	0.0		70.3	28.6	29.1	
28	71.4		81.1	22.5	22.5	
29	38.1		35.1	22.0	28.3	
30	0.0		10.8	22.2	..	
31	4.8		13.5	21.6	..	
32	4.8		5.4	19.1	..	
33	4.8	76.2	0.0	16.9	..	
34	33.3	19.0	21.6	15.5	..	
35	4.8		0.0	14.4	..	
36	4.8		8.1	12.7	..	
37	0.0		2.7	..	..	

Although a similar method was used with the 1926 class it was not employed quite so extensively nor was it quite as diagnostic as the method used this year.

S. R. Powers found that oxidation equations were very difficult for college freshmen in chemistry as well as for high-school chemistry students.

In Swarthmore, this kind of equation proved very troublesome, for in the 1927 chemistry class only 25 per cent of the slower section wrote the oxidation equation correctly, and of the brighter section 66.7 per cent of the responses were correct at mid-year. In June on the same question, 25 per cent of the slower section wrote the equation correctly while in the brighter section 44. 4 per cent of the answers were correct. This reaction was not emphasized in the second term although it was brought up on several occasions when similar reactions were being studied. It would seem to indicate that members of slower moving sections retain knowledge of subject-matter once mastered longer than members of brighter sections. However, the number of students in this investigation is too small to warrant the making of such a statement as a general conclusion. A further analysis shows that of the 12 students who made mistakes in this equation in January, 10 failed on the equation in June. Four new errants appeared on the June list, three of whom belonged to the brighter section. Furthermore, 8 of the 10 students made the same types of errors in June that they had made in January. The writer, therefore, concludes that very few oxidation reactions should be taught, and when they are taught or presented, the necessary time for drill work to attain mastery in 50 per cent of the cases should not be taken. Mastery in the brighter section may be required but in the slower section, time required for mastery is wastefully spent.

Table I is a summary of the types and percentages of errors made in problem work during the mid-year examination in January, 1927. It reads as follows: Section A (the slower section) made 54.6 per cent of all its problem errors in "principle;" Section B, 41.5 per cent; and the two sections combined, 51 per cent. The errors in mechanics are indicated under "mechanics." The number of problems wrong and the percentages of problems wrong in each section and in the sections combined are shown at the bottom of the table. Note that if errors due to omissions and guesses were classified under "principle" that from 70 to 80 per cent of the errors would occur under "principle."

Tables II and III read as follows: 85.7 per cent of the 1927 class in June answered question 1 correctly; 75.7 per cent of the 1925 class also answered it correctly; Powers' result for the same question is 81.7 per cent. Where the 1927 class had the same question in January as in June, that fact is recorded under the "Jan., 1927" heading. Where the letter "*C*" occurs in this column it indicates that in the January test the question is the completion type while the same question in the June test is multi-choice. Where no letter occurs after the percentage, the questions in both examinations are exactly the same. In Table III, where certain percentages are placed in brackets, it is indicated that a different compound or a different series of compounds were used in exactly the same kind of prob-

lem. Since all the errors in these two types of problems occurred in principle and nowhere else, the writer feels justified in using Powers' results in making the comparison. In Table III, those of Bennett's records which were available were listed.

In this article the lack of space prevents the writer from discussing fully the data presented in these few tables as well as the presentation and the discussion of other data which he has collected in this investigation. The investigator, therefore, leaves it to the reader to glean what points he may from the data set forth in this article. In question 16 of Table II the reader may be curious to know the reason for the improvement of the 1927 class over the 1925 class. The reason is this: This year, the instructor used the electrochemical series as a tool in teaching the properties of elements. With the 1925 class, the instructor used the periodic system as the tool in teaching the properties of the elements. This year, both the periodic and the electrochemical series were employed in teaching properties.

In questions 14–17 of Table III, the 1927 class not only surpassed the 1925 class but also surpassed Bennett's standard of achievement for the upper 401 cases of the 1470 cases tested with the Powers Test, Form B. In item 14 the upper 401 surpassed the Swarthmore group. Individual instruction and emphasis on memorizing valences of the elements and common radicals are surely the two factors which have influenced the achievement of the class.

The 1927 class shows improvement over the 1925 class in problem work as shown by questions 8, 13, 19, 20, and 25. One of the factors responsible for a better understanding of the principles of solving chemical problems is the increased emphasis which was given to problems during the second semester.

The percentage of correct responses to question 37 is very low, first because the problem is very difficult, and second because of the time element which prevents all students from having an opportunity to try the problem. The fundamental principle involved in 37 is the same as that of question 20. Question 37 requires the finding of two fundamental formulas and a comparison of the number of atoms of oxygen in the one with the number of atoms of oxygen in the other. One difficulty of this problem lies in the finding of the second fundamental formula. The ratio of two of chlorine to five of oxygen is not exactly 0.4 when solved with the data at hand. Therefore, the student is usually in a quandary at this point. If the ratios are 2 to 1, 3 to 1, 4 to 1, etc., even though ratios when solved are not quite equal to their exact values, the student usually recognizes the ratio. This particular type of problem with its two or more distinctly different steps the instructor has not included in his chemistry course. If the writer were to put this type of problem in the course, it would only

be given to the brighter section. If this problem had contained compounds with which the student was familiar a few would have been able to solve the problem. A question in the January test illustrates this point. Students were familiar with SO_2 and SO_3. Then, too, the ratios within each formula were simple ones, 1 to 2 and 1 to 3. In the question referred to, 42.9 per cent of the class answered the question correctly. Powers' standard for that question is 34.7 per cent.

Table IV represents a comparison of results of identically the same questions which appeared in the January and June examinations of the 1927 class. These questions belonged to the matching type. The elements and compounds were listed in a vertical column, each one followed by a series of numbered blocks. The answers were listed below the questions and numbered. The student placed checks in the blocks whose numbers corresponded to those of the correct answers listed below. The Roman numerals at the top of the vertical columns indicate the tables from which the data were taken in this investigation. The symbols or formulas listed directly below the Roman numerals stand for the elements or compounds whose properties the student is to determine from the list of ten properties given along the left-hand side of the table. On answer 2 to the question on oxygen, 80.9 per cent of the class in January indicated the answer correctly while only 46.6 per cent of the class responded in the correct manner in June. All of these substances were studied during the first semester. Only the study of CO_2 was continued in the second semester. Note that CO_2 is the only item whose percentage was appreciably increased in the June test. The properties of weight, whether the substances are heavier or lighter than air, are the most difficult ones for the class according to the averages listed for them at the extreme right. Notice in the case of oxygen that the class knows what supporting combustion means since their answers to questions 5, 7, 9, and 10 are 100 per cent correct. In their answers to 6 and 8 on burning, a few students have confused burning with the supporting of combustion. This question was called to the writer's attention several years ago in a general science class when he had given this multi-choice question in the test, "Oxygen burns, supports combustion, has no weight, or has color." Only 25 per cent of the class underscored "supports combustion." Of those who underscored the wrong answer, 90 per cent of them underscored "oxygen burns." The next year care was taken to present the topic of supporting combustion and burning to the class in such a manner that they would discriminate between the two terms. In the test which followed 96 per cent of the class answered the question correctly and of those who answered it incorrectly not one underscored "oxygen burns." Similar results have been noted in the chemistry class from year to year. The writer thought the technic of teaching discrimination in the use of these two terms had been mastered but in

TABLE IV

A COMPARISON OF TABLES I AND XI

Per Cent of Questions Correct

	I O	XI O	I H	XI H	I Cl	XI Cl	I N	XI N	I CO_2	XI CO_2	I NO	XI NO	I NO_2	XI NO_2	I Av.	XI Av.
1. Colorless	100.0	100.0	100.0	100.0	95.2	100.0	85.7	95.2	90.5	90.5	61.9	42.9	76.2	90.5	87.1	88.4
2. Heavier than air	80.9	46.6	95.2	95.2	85.7	85.7	61.9	71.4	71.4	66.7	42.9	52.4	52.4	76.2	70.1	70.6
3. Lighter than air	85.7	66.7	95.2	100.0	85.7	85.7	52.4	52.4	85.7	76.2	52.4	61.9	71.4	80.9	75.5	74.8
4. Same wt. as air	100.0	76.2	100.0	100.0	100.0	100.0	90.5	76.2	95.2	90.5	100.0	95.2	85.7	95.2	95.9	90.5
5. Supports combustion	100.0	100.0	90.5	90.5	71.4	71.4	85.7	71.4	85.7	85.7	100.0	76.2	71.4	52.4	86.4	78.2
6. It burns	90.5	85.7	100.0	85.7	95.2	95.2	90.5	85.7	80.9	85.7	95.2	76.2	95.2	95.2	92.5	87.1
7. Does not support combustion	100.0	100.0	80.9	80.9	76.2	66.7	76.2	71.4	76.2	80.9	52.4	71.4	80.9	61.9	77.5	76.2
8. Does not burn	85.7	80.9	95.2	85.7	80.9	85.7	61.9	85.7	61.9	85.7	66.7	71.4	61.9	90.5	73.5	83.7
9. A lighted stick thrust into it goes out	100.0	100.0	85.7	95.2	57.1	71.4	71.4	66.7	80.9	90.5	66.7	66.7	95.2	38.1	79.6	75.5
10. A lighted stick thrust into it continues to burn	100.0	100.0	100.0	95.2	61.9	52.4	80.9	76.2								
Average per cent	94.3	85.6	94.3	92.8	80.9	81.4	75.7	75.2	80.9	84.3	71.9	69.5	76.7	72.4	82.1	80.2

changing his testing procedure this last fall he received another jolt in the general science class.

After studying combustion, the general science class was given a multi-

TABLE V

DISTRIBUTION OF ERRORS IN NOMENCLATURE

Powers Test, Form B

1927 Percentage of names wrong, 59.5	1925 Percentage of names wrong, 39.2
Distribution of errors	Distribution of errors
"ite" as "ide," 8%	"ite" as "ide," 7%
"ite" as "ate," 6%	"ite" as "ate," 22%
"ite" as "bi-ide," 2%	Other "ite" errors, 11%
"ite" omissions, 10%	
"per-ate" as "ate," 10%	"per-ate" as "ate," 24%
Other "per-ate" errors, 10%	Other "per-ate" errors, 5%
*Methyl alcohol as a base, 6%	Methyl alcohol as a base, 2%
Methyl alcohol as an acid, 4%	Methyl alcohol as an acid, 2%
Other methyl alcohol errors, 32%	Methyl alcohol as ethyl alcohol, 16%
$K_2Cr_2O_7$ as "ate," 2%	$K_2Cr_2O_7$ as "ate," 11%
Other errors, 10%	

* The 1927 class studied no organic chemistry on account of a shortened school term due to building operations.

TABLE VI

DISTRIBUTION OF ERRORS IN WRITING FORMULAS

Powers Test, Form B

1927 Percentage of formulas wrong, 19.1		1925 Percentage of formulas wrong, 23	
Distribution of errors		Distribution of errors	
Valence	18.5%	Valence	39%
Molecular formula	50%	Molecular formula	23.4%
Molecular formula and valence	25.2%	Principle	22%
NH_3 for NH_4 in "ate"	6.3%	Carelessness	6.2%
		"ate" as "ite"	4.7%
		NH_3 for NH_4 in "ate"	4.7%

TABLE VII

DISTRIBUTION OF ERRORS IN WRITING EQUATIONS

Powers Test, Form B

1927 Percentage of equations wrong, 45.7		1925 Percentage of equations wrong, 58	
Distribution of errors		Distribution of errors	
Products	40.1%	Products	30%
Valence	3.9%	Valence	5%
Balancing	3.9%	Balancing	6%
Omissions	26.3%	Omissions	16%
Reagents	6.5%		
Formulas	13.8%	Formulas	23%
Molecular formulas	4.6%	Molecular formulas	20%
Symbol	0.7%		

choice test in which one or more answers to a question may be right. In that test on the question concerning oxygen, 92 per cent of the class underscored "supports combustion" and 60 per cent of the class also underscored "burns." Therefore, part of the class still confused the two terms although they underscored "supports combustion." They knew that supporting combustion was the better answer but when they had an opportunity to mark other answers as true they underscored "burns" as well. The writer

TABLE VIII

DISTRIBUTION OF ERRORS IN PROBLEMS

Powers Test, Form B

1927 Percentage of problems wrong, 61.9		1925 Percentage of problems wrong, 82.6	
Distribution of errors		Distribution of errors	
Omissions	29.7%	Omissions	55%
Principle	56.0%	Principle	37%
Guess	10%		
Mechanics	4.4%	Mechanics	8%

has put forth special effort to correct this wrong impression and the construction of the questions which are analyzed in Table IV represents an effort to test the student's power of discrimination and the teacher's ability to "put across" this particular idea on the properties of gases. These data show that there are still three or four students who cling to the idea that burning is the same thing as supporting combustion. In the cases of oxygen and hydrogen which were studied during the first semester, although the percentages are high for these responses, there is a slight decline. In CO_2, however, there is an increase in the June percentages over the January percentages because the study of carbon dioxide was completed in the second term. The results of these two tests on the particular item of discrimination referred to above certainly show a decided improvement when compared with results of previous years.

Tables V–VIII represent a comparison of the types of errors made by the two chemistry classes in the Powers Test, Form B. The percentages at the head of each column represent the percentage of that type of question answered incorrectly by the class. Under "percentage of errors," the table reads as follows: 8 per cent of the errors in nomenclature in the 1927 class occurred in writing the "ites" as "ides."

Surely one factor which has increased the percentage of correct responses in the case of the chemical problems is the increased emphasis upon problem work in the second semester.

Table IX presents a comparison of achievement in the various types of subject-matter as found in the Powers Test, Form B, for Parts I and II of that test.

TABLE IX

A COMPARISON OF ACHIEVEMENT IN TYPES OF SUBJECT-MATTER

Percentage Correct

Types	No. of items	June, 1927	June, 1925	Powers' standard
1. Composition	10	63.8	61.4	51.9
2. Definitions	7	61.2	66.8	68.1
3. Biography	3	42.9	36.0	48.3
4. Chemical changes	6	46.0	44.2	36.3
5. Use	2	42.9	41.9	23.5
6. Solubility	1	9.5	10.8	14.5
Average for Part I	4.8	44.4	43.5	40.5
1. Valence	4	95.2	83.8	..
2. Composition	8	43.5	44.3	44.0
3. Problems	7	38.1	17.4	..
4. Names for formulas	4	40.5	60.8	26.0
5. Formulas for names	4	80.9	66.9	57.7
6. Completion of equations	3	98.4	86.2	78.1
7. Entire equations	7	35.4	22.4	31.8
Average for Part II	4.6	53.4	47.5	35.0

Table X attempts to show how each student stands in regard to mental age, intelligence quotient, total scores made in January, and total scores made in June, and the ranking of each student on each one of the points

TABLE X

A COMPARISON OF SCORES, M. As., I. Qs. FOR THE JANUARY AND JUNE TESTS, 1927

No. of stud.	M. A.	I. Q.	Score, Jan.	Total score, June	Rank in M. A.	Rank in I. Q.	Rank in Jan. exam.	Rank in June exam.
1	17–8	110	64	56	16	16	8	12
2	18–9	117	51	52	7.5	8	16.5	14
3	18–9	117	63	67	7.5	8	9	6
4	17–3	108	53	64	17	17	15	8.5
5	19–3	120	57	50	3	3.5	13	15
6	17–1	107	29	24	18.5	18.5	21	21
7	18–2	114	78	69	12	11.5	2	4.5
8	16–4	102	56	44	21	21	14	17.5
9	18–3	114	44	45	11	11.5	19	16
10	18–6	116	51	53	10	10	16.5	13
11	17–1	107	48	44	18.5	18.5	18	17.5
12	16–10	105	32	34	20	20	20	20
13	19–2	120	69	69	4	3.5	6	4.5
14	17–9	111	59	58	15	15	10.5	11
15	17–11	113	59	63	13	13	10.5	10
16	19–6	122	77	77	1.5	1.5	3	1
17	19–0	119	74	73	6	5.5	4	3
18	19–1	119	72	66	5	5.5	5	7
19	18–7	117	58	39	9	8	12	19
20	17–10	112	67	64	14	14	7	8.5
21	19–6	122	82	74	1.5	1.5	1	2

already named. The mental ages and the I. Qs. of the class are based on the results of the Otis Group Intelligence Test, Form A, given in December, 1926.

The contrast between ranks of M. A. and I. Q. and the ranks of achievement in the two tests for student 7 is significant. Student 7 by his hard work and industry quite frequently surpassed students 16, 17, and 21 who learned much more rapidly and easily than student 7.

The reliability of the tools employed was tested out by means of standard deviations and coefficients of correlation. Space permits but a few of the correlations to be recorded here. The correlations were determined by the Pearson product-moment method.

January, 1927

Malin Test Scores with I. Qs., $r = +0.715$, P. E. 0.071
Malin Test Scores with M. As., $r = +0.644$, P. E. 0.086
Malin Scores with mid-year averages, $r = 0.931$, P. E. 0.0195

June, 1925

Powers Form B with M. As., $r = +0.866$, P. E. 0.027
Powers Form B, Part I with Part II, $r = +0.685$, P. E. 0.057

June, 1927

Powers Form B with M. As., $r = +0.577$, P. E. 0.034
Powers Form B, Part I with Part II, $r = +0.424$ P. E. 0.127
Powers Form B with Malin Test, $r = +0.896$, P. E. 0.052
Powers Form B with final averages, $r = +0.877$, P. E. 0.034

The conclusions to this investigation are based upon the writer's findings, only a small part of which are presented in this article.

Conclusions

Diagnosis of Difficulties

I. The kinds of difficulties met in the Swarthmore High School chemistry course can be classified under two general headings: "Information" (memory) and "tasks."

A. Information (memory)
   1. Definitions
   2. Biography
   3. Elements, Compounds, and Mixtures
   4. Composition
   5. Chemical Change
   6. Use
   7. Solubility

B. "Tasks" (involves memory and reasoning)

1. Valence
2. Problems
   (*a*) Principle
   (*b*) Mechanics
3. Naming formulas
4. Writing formulas from names
5. Writing equations
   (*a*) Balancing
   (*b*) Completing of equations
   (*c*) Entire equations.

II. Kinds of material found to be difficult in Powers' investigation also proved to be difficult for the two Swarthmore classes.

III. In general, the degrees of difficulty of each question in the Powers Test, Form B, as determined by Powers is experienced by the Swarthmore classes.

IV. The three types of subject-matter in the Powers Test, Form B, which proved to be the least difficult for the students of Swarthmore as well as for the students of Powers' investigation are: Completion equations; valence; and formulas, respectively.

V. The types of subject-matter in the Powers Test, Form B, which proved to be the most difficult for both classes are: Solubility; entire equations; and problems.

VI. In the Malin tests, the entire equations and problems are the most difficult types.

VII. In the Powers Test, Form B, the most difficult type of problem is the interpretation of equations although the hardest single question is number 37 on calculating formulas. The least difficult type of problem is the equation problem. (Question 13, Part II.)

VIII. The principal errors in writing formulas are in valence and writing the molecular formulas.

IX. Excluding alcohol, the principal errors in naming formulas are miscellaneous in character, no one type being predominant.

X. In Powers Test, Form B, the Swarthmore findings agree with those of J. C. Bennett in that the ability of students to write formulas from names is much greater than their ability to name formulas. The time element of the test is one cause of this noticeable difference and the second cause may be that the questions selected for naming formulas stand higher in degree of difficulty than those for writing the formulas. In the Malin tests where the time limits are eliminated the difference in the per cents of difficulty is insignificant.

XI. The types of errors in writing equations indicate that the class has

grasped the principle of writing equations because the most significant errors occur in products and omissions.

Diagnosis of Remedial Effects

I. The tables show the great improvement in solving chemical problems. There is a significant improvement in writing equations, valence, and naming formulas. In information of the memory type, there is little or no improvement.

II. The factors as listed below have had some effect on the improvement:

1. Analysis of individual difficulties, instruction for and practice by the individual concerned.
2. Greater emphasis on problem work during the second semester than formerly.
3. Requiring the students to memorize valences of the elements and radicals as they used them.
4. Greater emphasis on learning the principle of naming and writing formulas and emphasis upon learning the fundamental formula.
5. Requiring students to write molecular equations in their written work and in their laboratory work during the second semester.

III. The following factors have very likely retarded improvement:

1. A shorter school term.
   (*a*) No instruction given in organic chemistry.
   (*b*) No review before testing in June.
   (*c*) Tests during class periods instead of scheduled examinations for the finals.

IV. Time spent on oxidation equations in the slower-moving section is wasted.

Recommendations

1. A greater emphasis on the practical side of chemistry for the slower section.
2. Present not more than two oxidation equations in the slower section but do not require the mastery of these equations.
3. In the brighter section, present very few oxidation equations and require the mastery of only two or three of these equations.
4. The problem work of the slower section should be reduced still more to the simpler problems on the fundamental principles. These then should receive the greater teaching emphasis since the problem scope is lessened.
5. In the process of teaching the naming of formulas and the writing of formulas from names, more consistent emphasis must be placed upon the learning of the fundamental formula.

THE COMBINING WEIGHT OF COPPER

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This exercise is planned for those students entering the University with one unit in high-school chemistry or its equivalent. Quite a few of our students have already determined the combining weight of zinc (an element above hydrogen in the chemical activity series) in their entrance course, and by the time this exercise is assigned have also obtained the ratio of oxygen to hydrogen in water. Hence the equivalent of an element typical of those below hydrogen, such as copper, may be gotten in terms of zinc.

In carrying out this determination, most laboratory manuals direct that an excess of zinc be added to a known weight of copper sulfate in aqueous solution, a procedure which involves the removal of the precipitated copper from the remaining zinc. If a known weight of zinc (either mossy or sheet, preferably the latter) is added to an excess of the copper sulfate in solution, the removal of the copper from the zinc is obviated. Three grams of zinc and 14 g. of copper sulfate pentahydrate constitute suitable quantities. The deposition of the copper is accomplished within a few minutes if the zinc is added to the hot (almost boiling) solution of the copper salt. If the solution is boiling the finely divided copper constantly comes to the surface and is appreciably oxidized. If mossy zinc is employed, the reaction is facilitated by frequently breaking up the copper-zinc clumps.

The time consumed from this point on in the manipulation depends upon which of the three following methods is employed.

Method 1. The precipitate is filtered immediately on a common filter of known weight (or a tared filter), washed with hot water, and the filter containing the copper set in the desk to dry until the next period. The degree of oxidation is dependent upon the drying period.

Method 2. The precipitate is transferred to a common filter, the ash content of which is given with sufficient accuracy on the package, washed with distilled water, wood alcohol (and also with ether if desired), and allowed to drain for a few minutes. The filter is folded over the copper and the roll carefully dried in a heated and weighed crucible. When the drying is completed, the filter is incinerated and the crucible and contents are cooled and weighed in the customary manner. The amount of oxidation is proportional to the intensity and duration of the drying and incineration. It is interesting to note that the alcohol, ether, and filter afford a reducing atmosphere and cover for the copper. A filter of a high silica content is more satisfactory than one of the ashless variety as the siliceous material remaining after incineration also protects the copper from the air.

Method 3. While still in the beaker, the copper is washed by several decantations using hot water. The beaker is covered with an inverted watch glass, placed on a wire gauze and the water cautiously driven off over a low flame. The effluent steam keeps most of the air away from the copper. The beaker and contents may be allowed to cool either in the desiccator or the open air for a few moments and are then weighed. This method gives the best results of the three described here, but requires a little care in the avoidance of the destruction of the beaker near the end of the drying.

UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Patent Examiner.

Applications for junior patent examiner must be on file with the Civil-Service Commission at Washington, D. C., not later than March 10th. The date for assembling of competitors will be stated on their admission cards, and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies in the Patent Office at Washington, D. C., and in positions requiring similar qualifications.

The entrance salary is $1860 a year. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions.

Examination will be given in the optional subjects of mechanical engineering, physical and organic chemistry, chemical engineering, civil engineering, electrical engineering. French or German, or both, may be taken in conjunction with the optionals named above. Preference in appointment is being given to eligibles who attain eligibility in either, or both, of the languages, and in one of the optionals named above.

Competitors will be rated on physics, technics, and mechanical drawings; and the optional subject selected.

Full information may be obtained from the United States Civil-Service Commission at Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.

Experts Find Tropical Sun Keeps Babies Well. The only case of rickets that experts from the U. S. Children's Bureau found in a recent survey of 600 Porto Rico babies was in an infant that had spent five of its six months in a cellar lighted only by electricity.

The survey was undertaken under the direction of Miss Grace Abbott, chief of the bureau, to determine the effect of the tropical sun on rickets, the disorder of the mineral chemistry in the bodies of young children that is prevented by the action of ultra-violet rays. It is especially desirable, Miss Abbott pointed out, to have a series of x-ray pictures of the bones of babies who live in the tropics because they normally spend most of their waking hours with their little bodies completely exposed to the beneficial action of the sun. The photographs will be used to compare with those of children in temperate climates so that some sort of a standard can be obtained of what the healthy bones of a growing child should look like.—*Science Service*

Chemical Digest

ABSTRACTS

Freezing Flames to Check Their Spread. ANON. *Compressed Air Mag.*, **32,** 2177 (Oct., 1927).—This article describes a fire extinguisher which puts out fire by lowering the temperature of the fuel to a point below its kindling point, through use of liquid carbon dioxide. E. R. W.

A Standardized Mental Test vs. an Unstandardized English Test as a Means of Predicting Success in College English. T. M. CARTER. *Sch. and Soc.*, **26,** 151–2 (July 30, 1927).—The mental test which has been given to incoming students at Albion College for several years was made, this last year, a part of the Freshman week activities. The results of this test, along with all other available records, were used in grouping the students and, in addition, a brief preliminary test in English was prepared by the head of the English department. The coefficient of correlation resulting from the ratings of the psychological and English tests are given; also the means of determining the correlation between college grades and the two tests mentioned above are stated. K. S. H.

An Objective Study of Student Honesty during Examinations. N. FENTON. *Sch. and Soc.*, **26,** 341–4 (Sept. 10, 1927).—Three of the most reliable students in an institution where the honor system did not exist, chose as a thesis topic the problem of "Student Honesty during Examinations." These three students were so seated among the other students at various examinations that each had a definite number to watch over. Any evidences of dishonesty were recorded, and it was found that about 63 per cent of the students actually cheated. The manner in which these examinations were conducted and the conditions, etc., under which they were held are given.

The writer states that until training in honesty is provided in the primary grades, we cannot expect it to exist among students in the higher schools. K. S. H.

Freedom and Education. O. DECROLY. *Sch. and Soc.*, **26,** 353–5 (Sept. 17, 1927).—The writer explains the meaning of the word freedom with reference to the child, stating that the opinion commonly held is that of mere laxity. The advantages and disadvantages experienced by children of the middle class and those of the aristocracy, of city and of country life, are discussed.

From an educational standpoint, that child who is least restricted appears to be the better fitted for his environment. K. S. H.

The Junior and Senior Colleges in a College of Liberal Arts. J. B. JOHNSTON. *Sch. and Soc.*, **26,** 302–7 (Sept. 3, 1927).—The Univ. of Minnesota was one of the first of the state universities to make a distinction between the junior and senior colleges, hence the statements made in this article are in response to letters of inquiry regarding such a distinction at this University—objectives, curriculum, student problems, etc., being considered.

The junior college is concerned with: the presentation of a well-prepared and organized body of secondary studies; professional courses; and with constituting a testing ground to determine the fitness of students for the professions and for more advanced study.

The senior college is concerned with: general education resulting in independent thinking and an ability to do research; and preparation for college teaching. For those students who have no definite intentions, a special curriculum is offered.

The method of instruction in the two colleges necessarily varies because of a difference in the type and number of students, and the nature of the subject-matter. Recitations, discussions, and quizzes constitute the greater part of the program in the junior college, while in the senior college, the lecture and seminar method prevail. In 1915–16, a plan for "honors courses" work was introduced in the senior college, the students being selected and the plan meeting with considerable success.

The services of a committee on general educational and vocational guidance are available to any freshman during Freshman Week activities. The method of registration, which differs considerably from the ordinary, the provisions made for advising the students, and the type of students with whom the counsellors deal are discussed.

K. S. H.

College Libraries and Chemical Education. P. L. K. GROSS AND E. M. GROSS. *Science*, **66**, 385–9 (Oct. 28, 1927).—The relative usefulness based on past as well as present content of the various chemical periodicals is shown by tabulating all references to foreign journals in Vol. 48 (1926) of the *J. Am. Chem. Soc.* For the American College which is preparing students in chemistry to do graduate work at other institutions the following list of periodicals (current and files) are recommended: (1) Publications of the A. C. S., (2) *Ber.*, complete, (3) *J. Chem. Soc.* (London) from 1891, (4) *Z. phys. Chem.* from 1895, (5) *Liebig's Ann.*, files important, and static reprints are available, (6) *J. Phys. Chem.* from 1910 or 1920. Other highly desirable journals are listed in order. G. H. W.

What Price the Ph.D.? ANON. *Harvard Alumni Bull.*, **30**, 33 (Oct. 6, 1927).—"It is estimated that a Ph.D. from Harvard is worth in the neighborhood of $30,000." Thus speaks a Boston newspaper after a survey of the teaching careers of Harvard graduates with and without the higher degrees. And further along in the same account stands the statement that "in private secondary schools . . .graduates have been able to capitalize on athletic ability to the extent of about $500 a year in addition to the average salary." A notable victory for scholarship! A Ph.D. can earn $1000 a year for thirty years in addition to what he might have earned without his doctorate; an athlete only half as much and that only as long as he is young enough to coach. The reckoning may be a bit rough, but we are comforted. The Press has recognized the money value of learning.

The article in question is not, as a matter of fact, a "recognition" of anything. It is a very simple statement of certain interesting trends in the salaries paid to Harvard men in teaching. Graduates without higher degrees find it impossible to secure positions as teachers in colleges. The raw A.B. may teach in the schools, particularly in private schools and more certainly if he has a record in athletics wherewith to supplement his record in studies. He may start at $1400 a year. The M.A. may start in school or college at $1800; the Ph.D. has a good chance to get a college post at $2500. "Few teachers with only an M.A. degree are able to earn more than $3200 a year;" whereas those who have the Ph.D. are likely to go as far as $6000 after which "the professor must depend almost exclusively on his writing for any additional monetary reward." Colleges with lower standards place a higher artificial value on the Ph.D.; and the professional schools, which pay more than the colleges, think less highly of degrees of any kind.

The article closes with a significant paragraph: "Although teaching has for many years been looked upon as an under-priced profession, . . . men can earn more in the first few years in teaching than in business. This has attracted hundreds into teaching for a few years while they earn enough to study in a professional school. If they abandon their professional plans they find it embarrassing to leave teaching for business at a lower income, and this dilemma supplies the great bulk of the teaching profession of this country." This statement is intended, obviously, to apply to teachers in the schools, not in the colleges; for the Ph.D. who enters college teaching has already had a prolonged training and is not teaching temporarily in the hope of entering another profession later on. It brands the teachers who are not Ph.Ds. as "left-overs."

Nothing in all this is new, except perhaps the attempt to estimate the money value of degrees. It does serve, however, to emphasize the fact that America does not really value education, nor take it very seriously. We have faith in education, but our faith finds its expression in externals—in buildings, textbooks, organization. We expect miracles of requirements and courses of study. We do not take education seriously because we do not yet understand that the heart of the educative process is the teacher and that we must have for teaching from the beginning to the end the best talent that money can buy. It is an old story, but we have not heard it often enough to act on it. When teaching pays very little at the beginning and far more in every grade at the end; when teachers in schools are equal in training and value to teachers in colleges; and when preparation for any teaching whatever is far more prolonged and severe than it is at present, our "faith" in education will be matched by "works." S. W. H.

American Chemical Society. EDITORIAL. *Tech. Rev.*, **30**, 11 (Nov., 1927).—James Harvey Robinson once wrote a book, "The Humanization of Knowledge," which surely the leading spirits in the American Chemical Society have read or heard of, to judge from the discussion topics on the agenda of their meeting programs. No American society is so industriously concerned in the humanization of knowledge as is this one; it must be confessed that at times they seemingly overshoot the mark and furnish material for such critics as Arthur Lynch ("Science Leading and Misleading") and C. E. Ayres ("Science: The False Messiah").

At its meeting held in September at Detroit, many subjects of a non-technical nature were discussed: the present age was termed the Age of Chemistry, perhaps to compete with similar terms, such as the Age of Electricity, the Machine Age, and so on; it was declared that "Science has killed the navies of the world;" an appeal was made for a return to the idealism of Ralph Waldo Emerson; the abandonment of the classics was deplored and chemistry declared too materialistic. Certainly all of this is indicative of a lively culture among chemists. This fact has frequently been observed, though no one has ever suggested why chemistry, more than any other science, with the possible exception of physics, stimulates its practitioners to broad and humanistic ways of thought.

At the Detroit meeting the organization of a division of the history of chemistry was announced, for which Tenney L. Davis was appointed Secretary. Researches into the history of science are to be conducted by the division "to bring about greater emphasis on the humanities in scientific education." Professor Davis himself, possesses a unique collection of early books on science and related subjects. S. W. H.

The Key to What? EDITORIAL. *Harvard Alumni Bull.*, **30,** 123 (Oct. 27, 1927).—"Have members of the Phi Beta Kappa during the century and a half since it was established, contributed more than their due proportion to the ranks of the leaders in all branches of American life?"

This is a question which John Clair Minot of the *Boston Herald* undertakes to answer in the current issue of the *North American Review.*

The total membership of the Phi Beta Kappa, he points out, has never exceeded three one-hundredths of one per cent in the national population. In 1900, twenty-nine Americans were chosen to have their names emblazoned in the Hall of Fame. The selection was made with great care and deliberation from among the long list of outstanding figures in American literature, science, statesmanship, and all the other conspicuous fields of human activity. Thirteen of the twenty-nine were members of the Phi Beta Kappa. One adult American out of 2000, on the average, gets his name in "Who's Who," but among the living wearers of the Phi Beta Kappa key the ratio is one to five.

Eleven of the twenty-nine Presidents of the United States, five of ten Chief Justices of the Supreme Court of the United States, and eighteen of forty Secretaries of State have been members of Phi Beta Kappa. S. W. H.

The Goal of Education. EDITORIAL. *Harvard Alumni Bull.*, **30,** 209–10 (Nov. 17, 1927).—Arthur Stanley Pease, '02, was inaugurated President of Amherst College a fortnight ago. His inaugural address contained many significant passages, but the one that seems to be attracting the largest amount of attention is his reference to the obligation of the liberal college in the matter of training men to use their leisure hours aright. Teaching young men how to make an ennobling and effective use of their leisure in after life he declared to be one of the main functions of a college, and not simply an incidental one.

It was a good point on which to set emphasis. During the past half dozen years there has been, perhaps, too much stressing of higher education in its purely vocational aspects, and too much discussion of its value as a passport to quick success in business or in the professions. Every little while some statistician, with a firm faith in the law of averages, figures out the value of a college degree just as a real estate dealer would calculate the front-foot value of a corner lot. Incidentally, the former always demonstrates that the earnings on money invested in tuition fees are so big that if they came within the provisions of the Transportation Act they would be subject to recapture.

That kind of thing may be well enough in its way, but it tends to stamp upon the public imagination an idea that the college undergraduate is merely making a sort of prevocational investment, the justification of which lies wholly in the speed with which he can command a good livelihood after he graduates. And, as an inevitable corollary, comes the demand that college instruction be frankly adjusted to what these young men are planning to do when they get out into the world. This demand, indeed, has reached a point where the colleges are being vociferously urged to obtain "job specifications" from the industries, banks, and other big employers of fledgeling graduates in order that undergraduate instruction may be revamped along the "practical" lines which such specifications may suggest. This notion that a college is nothing more than a place where men are trained to get jobs, and hold jobs, has spread far. It is well that President Pease should have pointed out that a college is not fulfilling half its true purpose if it does this and nothing more.

The college should assume that most of its graduates will succeed, make money,

and have leisure at their disposal. Experience warrants this assumption. But what will its graduates do with spare time when it comes to them in the due course of human events? Everybody knows that there are thousands of reputedly successful men to whom leisure is a burden because they have never discovered any satisfying way of using it. It is one of the prime functions of a liberal college to keep its graduates from drifting into that category. This it should do by encouraging in its students breadth of intellectual interest, versatility, and a spirit of public service. Such qualities can never be developed by warping the college curriculum, or the methods of education, into unison with any set of job specifications wheresoever obtained. S. W. H.

Too Many Colleges and Students? EDITORIAL. *Harvard Alumni Bull.*, **30,** 2 (Sept. 29, 1927).—The seasonal migration of American youth to several hundred "centers of learning" serves to shift attention from trans-oceanic aviation, the Davis Cup, and heavy-weight prize-fighting to the lateral pass and the problems of higher education. We are again reminded, this time by President Angell in *Harper's* for October, that our colleges are said to be "over-populated." The writer reopens the debate by pointing out that the question is really a qualitative rather than a quantitative one. If our colleges were thronged with eager scholars, hungering for truth, and intent upon the rewards of the intellectual life, we should not be dismayed. There would be a momentary embarrassment, perhaps, like that of a merchant who has more customers than he can accommodate, but he would cheerfully enlarge his plant and increase his stock. The real problem lies not so much in the fact that there are too many students, but rather in the fact that too many of them are not students. There are too many men and women in college who are inadequately endowed, inadequately prepared, and inadequately motivated to obtain from college what the college is designed to give. It is as though the merchant were to find his premises occupied by people who had neither the money nor the desire to buy his wares, and who obstructed his real customers.

Thus to view the matter from the qualitative rather than from the quantitative angle offers the best prospect of a wise solution. Any given college may limit numbers according to its resources or methods of instruction, but if those excluded go to other colleges, or are left out altogether, the general issue is only evaded. And who can meet this general issue on qualitative grounds? Who can tell us just what proportion of Americans should receive a college education? Even if there were among us any wise enough to define that proportion, who is prepared to answer the claims of an ambitious and qualified youth who finds himself excluded? In view of these difficulties it seems prudent to begin with a problem which lies more clearly within the competence of teachers and educational leaders. This would mean that one would employ methods of selection not to reduce numbers, but to eliminate those whose attendance at college is unprofitable to themselves or to society. Reform would be pointed toward the *improvement* of the educational process, and not toward its reduction. Incidentally, for a time at least, the solution of the qualitative problem would solve also the quantitative problem, but it would do so without the adoption of any hasty or reactionary social philosophy. It would raise educational attainment without denying such attainment to any man or any number of men who proved themselves capable of it.

If there is anything wrong with the American college, it is not that there are so many of them, or so many students attending them, that an observer so well-informed and so temperate as President Angell can say, "Put the blame where you will, we have not developed in this country any general respect for scholarship as such." S. W. H.

The Reading Periods. EDITORIAL. *Harvard Alumni Bull.*, **30,** 270 (Dec. 1, 1927).—"The first reading period will begin immediately after the Christmas vacation and will continue until the midyear examination.

"This experiment in the suspension of teaching has aroused a great deal of interest all over the country, and naturally so, for it is a radical departure from the time-honored way of doing things.

"Harvard is the first to declare a moratorium on the activities of virtually the whole teaching staff during two considerable stretches of the academic year.

"Teaching will cease, but study will not. The undergraduates will be given work to do in their own time and way. Examinations will come at the close of each reading period.

"It is a high tribute to the increased seriousness of the Harvard undergraduate body that the Faculty is ready to place about 2500 young men 'on their own' for a three weeks' stretch without any daily check-up whatever.

"These reading periods will give members of the Faculty a better opportunity

to read, to study, and to write. They will contribute to better teaching in the long run."
S. W. H.

The Reading Periods. CLIFFORD H. MOORE. *Harvard Alumni Bull.*, **30,** 287–8 (Dec. 1, 1927).—Professor Holmes explains this new departure in Harvard teaching in a two-page article. S. W. H.

The Cost of Higher Education. EDITORIAL. *Harvard Alumni Bull.*, **30,** 242 (Nov. 24, 1927).—"The undergraduate tuition fees of thirty privately endowed colleges and universities are displayed in an interesting table which is the central feature of a booklet called 'Tuition Fees and College Financing' issued by the John Price Jones Corporation of 150 Nassau St., New York.

"This table shows the fees of 21 men's colleges and 9 women's colleges by years from 1907–08 to 1927–28; and for comparison sets against the tuition averages year by year the index figures (1913 = 100) for the average income per capita, for the cost of living, for retail food prices, and for bank deposits.

"The essential facts are these: twenty years ago the average tuition at men's colleges was $125, at the women's colleges $147; to-day the averages are, for men, $329; for women, $343. The index figure for tuition fees started well above the index figures for income, etc., but since 1913 bank deposits have climbed much higher, per capita income has been steadily somewhat higher, the cost of living was higher until 1925–26, and retail food prices were higher until 1921–22.

"Tuition costs, in other words, have increased but not alarmingly in relation to available wealth." S. W. H.

Wasted Millions. W. J. HALE. *Collier's*, **81,** 29 (Jan. 7, 1928).—It is estimated that yearly America wastes 600 billion tons of farm products worth $5.00 a ton. Farmers should be regarded as producers of organic chemicals.

It is a waste to raise corn merely to feed animals. Corn stalks are more than 30% cellulose of such high purity that out of it can be made artificial silk and motion-picture films. Corn cobs can be distilled to yield an adhesive and furfural, a compound of innumerable uses. Cobs and stalks make up ¾ of the corn crop. From the grain itself may be obtained cooking oil, paragol (a rubber substitute), gluten, phytin, starch, glucose, corn sirup, butyl alcohol, acetone, and ethyl alcohol.

Common milk-weed possesses a fiber that may be used to replace flax. Its juices yield a resin latex used as licorice substitute. Its juice also promises rubber.

Three billion pounds of whey go to waste every year in cheese factories. Millions of tons of cellulose in straw are discarded in American grain fields.

Wastes in fruits are noted annually, but one factory in California uses 30,000 tons of surplus lemons per year to make citric acid and lemon oil.

Organic chemistry holds the key to the solution of the so-called "farm problem" and the organic chemist will be busily engaged henceforth in turning the American manufacturer's attention to the American farmer as the producer of the best raw materials. J. W. H.

Farewell to Pedagogy. BERNARD DE VOTO. *Harper's*, **156,** 182 (Jan., 1928).—For a thousand years the history of the University has been the history of civilization, nevertheless it is true that the teaching profession was never in greater chaos than today and the problems confronting the colleges more difficult. A panic has settled on the colleges in their attempts to define their aims and purposes.

Part of the trouble is that students regard the instructors as nincompoops and those outside of the campus regard them as halfwits. The idea is that they teach because they cannot get any other job. This is absurd as professors are responsible for all that is admirable in the recent progress shown in all branches of learning. The trade of pedagogy for the most part is made up of highly skilled men who are highly competent at their business. In any other profession, however, the incompetent and brainless settle to the bottom where they are impotent, but in pedagogy they become professors of education, then Deans, and finally Presidents. It must be admitted that some professors of education are aware that their science is preposterous and a few are actually doing valuable work. These few are like the good men in stews and hop joints—still you must hold to your judgment of people who frequent such places. The greater part of the present plight of the colleges is due to this group of uneducated fanatics, crazed enthusiasts, or wilful charlatans, who have, in the past fifteen years, ridden into power. To improve the colleges get rid of the fools who roam among them and begin with the professors of education.

Another way to improve the colleges is that they become specialists in certain lines of endeavor instead of trying to cover so many fields. Sheer power of numbers and economic necessity will in time force them to do this. J. W. H.

Science and the Wealth of Nations. GEORGE ELLERY HALE. *Harper's*, **156,** 243 (Jan., 1928).—The "practical man," with his haste for immediate returns, often fails to see the vital need of pure science. But the wider the vision and more powerful the constructive imagination of the statesmen and business leaders who rise by these qualities above mediocrity, the greater is their appreciation of the relation between pure science and industrial and national progress. Our place in the intellectual world, the advance of our industries and our commerce, the health of our people, the production of our farms, the conditions under which we live and labor, and the prosperity and security of the nation depend on our cultivation of pure science.

Industrial research is directed only toward the solution of some particular problem encountered in the industries. Fundamental research in pure science, on the contrary, is conducted for the purpose of increasing knowledge through the discovery of new laws of nature. Such discoveries are much more important to industry than the narrower conclusions of industrial research. The development of a complete field of industrial endeavor may spring from the applications of a single new law of nature. Many examples of this are cited. Illustrations are not only given from industry but from public health and medicine.

In order to multiply such cases conditions of research must be made more favorable than they are now. The National Academy of Sciences has undertaken to secure a National Research Fund chiefly for the purpose of aiding the ablest American investigators, most of whom hold positions in universities and colleges, to conduct their researches to the best possible advantage. J. W. H.

A Modified Form of the True-False Test. H. Y. MCCLUSKY AND F. D. CURTIS. *Sch. Sci. Math.*, **27,** 362–6 (April, 1927).—Three objections to True-False test as originated about seven years ago: (1) Facilitates proclivity to borrow from one's neighbor; (2) unsatisfactory as an instrument for diagnosing special individual difficulties; and (3) permits more or less successful guessing. May be overcome by a modification of the test in which student is required to correct the false statement by substituting a given number of words; *e. g.*, not more than two, etc. Use of the word *not* and change of subject is not allowed.

Investigation by use of this modified form furnished evidence for following conclusions:

(1) Modified form requires more time to administer than True-False—38.2% of median time increase. Also greater time required to mark modified forms.

(2) Modified form more useful in drill upon units and diagnosis of individual and group weaknesses.

(3) Modified form is better power test.

(4) Modified form is more reliable by Brown's formula. Reliability is 0.93 and True-False is 0.82.

(5) Modified form is more difficult for pupils.

(6) Modified form tends to eliminate guessing—and could eliminate all guessing if all statements were made false. B. H. B.

The Evolution of Industry as Related to the Evolution of Scientific Knowledge. R. E. ROSE. *Sch. Sci. Math.*, **27,** 379–89 (Apr., 1927); and **27,** 488–99 (May, 1927).—A splendid paper well adapted for inspirational reference reading by science students. B. H. B.

Aim and Content of Chemistry Laboratory Manuals. C. M. PRUITT. *Sch. Sci. Math.*, **27,** 507–11 (May, 1927).—An investigation to determine correlation between aims of chemistry teaching as set forth in *Bur. of Educ. Bull.*, entitled "Reorganization of Science in Secondary Schools," and the "Aim and Content of Chemistry Lab. Courses."

Analysis of contents of 15 representative manuals was made by classifying experiments under 7 headings though it is acknowledged that classification was somewhat arbitrary as well as selection of headings. Such a table shows wide variation in contents.

Analysis of correlation of aim and correlant was then made on a point scale: 1 for low degree of correlation and 4 for high degree of correlation. This analysis also showed low degree of correlation.

Conclusion drawn is that too much of the laboratory work in high school is preparation for college. Later manuals have been much improved in correlation both with aims and content. B. H. B.

Johann Rudolph Glauber. DAVID PATERSON. *Dyer and Calico Printer*, **58,** 226 (Dec. 1, 1927).—Johann Rudolph Glauber—born 1604, died 1668. Little is known of his personal life before he settled in Holland as a manufacturer of chemical and medicinal

drugs. Though many of his ideas were alchemistic he explained for the first time the true nature of double decomposition, described the action of vitriol on NaCl and nitre to give HCl and HNO_3, discovered Glauber's salt, and prepared a large number of the salts of Pb, Sn, Fe, Zn, Cu, Sb, and As. He was always anxious to apply his knowledge, whether to medicine, or dyeing, or agriculture. Chloride of gold he recommended for ulcers and leprosy and other sores of the skin, in addition to being a valuable cure for intoxication, a remedy still used commercially. He constantly urged Germany to work up her raw materials into useful products rather than export them. He described evaporated malt for concentrated nourishment for sailors. His collected writings, "The Works of the Highly Experienced and Famous Chymist, John Rudolph Glauber, Containing a Great Variety of Choice Secrets in Medicine and Alchymy," are a curious and interesting collection of facts, many of which seem to be quite modern. G. B. R.

The Deficiency of English Units of Measure and Weight for Scientific and Technical Uses. SAMUEL RUSSELL. *Science*, **66**, 481 (Nov. 18, 1927).—"To supply the deficiency of our common units in the field of technical and scientific measures and weights, it is proposed that the foot be divided on the decimal scale into 100 lines and 1000 points and that the ounce be divided into 8 drams, 100 centos, and 1000 moits, the ounce being the cube of the tenth of the foot, the dram the cube of the twentieth of the foot and the moit the cube of the hundredth of the foot of water at the maximum density."

"For definitive purposes it is proposed that the foot be taken as the length of 473,404 waves of red cadmium light, that the ounce be taken as the weight of 28,316 milligrams and that new material standards or master bars and weights be constructed from these definitive values." G. H. W.

Gain in Chemical Engineering Courses Enrolment. EDITORIAL. *Tech. Rev.*, **30**, (Nov., 1927).—The course in chemical engineering stands fourth numerically among the courses given at the Mass. Inst. of Tech., with an enrolment of 296 for the year 1926–27. It also stands fourth for those showing a gain in enrolment. The gain was 17 or 6.1 per cent over 1926–27. S. W. H.

The Chains of Prometheus. BENJAMIN C. GRUENBERG. *Sci. Mo.*, **25**, 504–10 (Dec., 1927).—While an increase of knowledge means an increase of power it means also an increase of sorrow. This is made very evident by a number of examples. To the degree that scientists are permitted to influence our customs and laws, to that degree are we beset with regulations, restrictions, and interferences with our natural modes of life. The more we learn about the obscure forces and invisible processes, the less freedom have we to do as our impulses direct or as our traditions demand. Scientific knowledge has accumulated faster than the general population can assimilate it. It is not enough to tell the world, for example, that iodine is of value in preventing simple goiter: the world ought to know how that was found out. Advancement of science means not only deriving new power and new freedom, it means also the acceptance of new disciplines and new obligations. G. W. S.

The Berthelot Centenary. ANON. *Sci. Mo.*, **25**, 567–8 (Dec., 1927).—A brief description of the ceremonies accompanying the laying of the corner stone of "The International Chemical House" which is being erected as a memorial to Marcellin Berthelot. Subscriptions have been received from 40 nations, contributions from the U. S. amounting to about 500,000 francs. The purpose of the memorial is similar to that of the Pasteur Institute. A full-page photograph of Berthelot accompanies the description. G. W. S.

Radium at the Memorial Hospital. GIOCCHINA FAILLA. *Sci. Mo.*, **25**, 568–74 (Dec., 1927).—A description of the method of handling a mass of 4 g. of radium when used for therapeutic purposes is described. The radium is heavily protected with lead, the container weighing about 200 lbs. G. W. S.

A World Bureau of Education. G. W. A. LUCKEY. *Sch. and Soc.*, **26**, 464–6 (Oct. 8, 1927).—The author advocates the creation of a World Bureau of Education with a view to stimulating the promotion of learning. That the need for such an organization has been keenly felt by thousands of able educators the world over is evident from the efforts of many to create organizations, the ultimate aim of which would be their development sooner or later into some such organization as the above.

It would seem advisable that such a Bureau of Education be an outgrowth of the League of Nations if it is to be efficient and of universal service—the League of Nations being more or less firmly established, sympathetically and intelligently backed, and in active operation. A bureau of this type, with representatives from the various countries, could accumulate a vast amount of knowledge otherwise unobtainable. A living organism—nourished with the best food of its kind, it would tend toward a forward and

upward movement of civilization. There would and probably always will remain major differences in the educational systems of the various countries, but knowledge could be so sorted and distributed, that every institution could have the advantages of the best. K. S. H.

The Honor System and the Normal Curve. H. C. HINES. *Sch. and Soc.*, **26**, 481–5 (Oct. 15, 1927).—Because individual interpretations of the standards of honesty differ, no one can be considered absolutely honest at all times—hence no honor system can prove effective in raising moral standards, particularly when one considers the numbers and different types affected by its administration. Also, each instructor has his individual way of determining what may be cheating during examinations. Consequently, in judging an honor system, we must remember that the student who cheats is subject to permanent reform, and that an honor system is of value only if it raises the ethical standards in an institution. K. S. H.

What Place Have Educational Courses in a Liberal Arts College? J. H. SINCLAIR. *Sch. and Soc.*, **26**, 498–500 (Oct. 15, 1927).—Both faculty and students generally assume that educational courses in a liberal arts college are without value except to fulfil state requirements. On the contrary, such courses may be made very valuable to students. A course in the philosophy of education could be so taught as to make clear to a student the true meaning of education and thus aid him in his college life and in his own education. A department of education should have two aims: First, to give educational courses of fundamental importance to all the students of a college; and second, to give courses that are purely vocational. K. S. H.

Results Obtained in a Special "How to Study" Course Given to College Students. WM. F. BOOK. *Sch. and Soc.*, **26**, 529–34 (Oct. 22, 1927).—Failure of students to orient themselves at college results in the common practice among colleges of dismissing from one-fifth to one-third of the freshman classes, because the students fail to maintain scholastic standing.

Realizing that most failures are due to remediable causes, most institutions are now conducting a "How to Study" course. If every teacher taught so as to lead his students to work in the proper manner instead of merely mastering his particular subject, the orientation course would be unnecessary, but since this is not the case, the "How to Study" course is proving most valuable.

The author tells of the orientation course given at Indiana Univ. It was found that students were not using their time efficiently, and so the teaching of a time schedule gave students a valuable insight into a more effective way of working. Another difficulty to be met was the fact that many students were unable to get accurate information quickly. Here a course in effective reading practically doubled their efficiency in this direction. A third division covered instruction in the planning of work to be done. Numerous tables are given to illustrate the gain made.

The great improvement made by freshmen who took the "How to Study" course proves conclusively the need of such instruction. K. S. H.

The Honor Plan at Cornell University. ANON. *Sch. and Soc.*, **26**, 515–6 (Oct. 22, 1927).—The formation of a joint Faculty-Student Committee for the purpose of considering matters relating to the conduct of examination has been authorized and approved by the Cornell University faculty. The resolution as adopted by the College of Arts and Sciences of this University is stated in this article. K. S. H.

Improving Teachers in Service. F. D. BOYNTON. *Sch. and Soc.*, **26**, 523–4 (Oct. 22, 1927).—Plans for the improvement of teaching effectiveness are discussed by the author who says that only a few remain of that vanishing race who consider their diploma a sort of intellectual mattress upon which to allow their minds to rest undisturbed.

The present-day teacher is progressive and ambitious, as university registrations, particularly Summer Session statistics, indicate. Summer Session work, however, is considerably less desirable than the courses offered by the regular faculty during the academic year.

Instructors and the courses they offer for candidates who seek advancement should be carefully selected and considered. After receiving a degree, backed by substantial work, and after having served a community for a given length of time, the teacher should be granted a leave of absence for further study on part salary—such work as the teacher may desire to undertake being approved before such leave is granted. K. S. H.

Overproduction in Higher Education. B. RUDMAN. *Sch. and Soc.*, **26**, 558–60 (Oct. 29, 1927).—Colleges all over the land are suffering from an influx of students who are unfitted for the environment of college. The author feels that this type chooses college as the path of least resistance, thinking that a college degree is a key to success.

Mr. Rudman would warn such students, and their parents as well, that a degree does not necessarily lead to success—that business and industry are now excluding college men. If this were more definitely understood, many of this type would enter business and industry after high school, and would achieve real success instead of maladjustment to their environment as is the case when they go to college.

K. S. H.

College Teaching. E. H. WILKINS. *Sch. and Soc.*, **26,** 567–71 (Nov. 5, 1927).—Dr. Wilkins, in his inaugural address, says, "Teaching is the thing primarily expected of the college." It is that at which the college excels and is best qualified to do, and the quality of its teaching is the measure of the success of a college. Upon the faculty rests the real life of the college and it is of vital importance that each faculty member be a good teacher.

A good teacher has a thorough knowledge of his subject and he considers his students as individuals. His lectures show careful thought and preparation as well as good organization, and the presentation of his material is accomplished with informality which tends to discussion, thus making his subject a constant stimulus to students.

In choosing a college faculty, the main point of consideration should be teaching ability; then having obtained good teachers, the institution must maintain good teaching conditions. This involves good teaching tools—*i. e.*, the best possible laboratory equipment; the best library collection possible, with a comfortable reading room; and, finally, class-rooms that prove a stimulus to an interest in the subject taught. Prof. Cowles of Amherst had, in his class-room for Latin, literature, pictures, models, and coins of Roman origin, and thus made his subject alive to his students.

The teacher should be given adequate time for preparation as well as for thoughtful consideration of his subject. He should be encouraged to attend local and national gatherings of those working in his field. In short, he should be given every stimulus to broaden his viewpoint. His compensation should be such as to permit his living in dignity and comfort.

If a college so selects its teachers and so treats them, and the teachers respond to this, great educational achievement can be accomplished. K. S. H.

The Professor and His Hire. (Quotation from *N. Y. Times.*) *Sch. and Soc.*, **26,** 656 (Nov. 19, 1927).—Still unrecognized by those who give millions for the erection of college buildings is the fact that these buildings must provide professors as well as janitors, and that the laboratories must furnish teachers in research. To endow learning is one thing; to recognize the proper proportions between the walls and the brains of a university is another.

College teaching claims its reward in love for the work and opportunity for service, and not in the salaries provided. Much lower is the salary and also the prestige of an American university teacher than of a teacher in a European university. Ellsworth Huntington and L. F. Whitney are quoted from their "Builders of America" as saying that the American college professor must, on account of his salary, be extremely cautious in raising a family, and because of this, reproduction among the best American stock is discouraged. They urge those who would give millions for the erection of college halls, etc., to give only a portion for this purpose, creating a fund out of the remainder "to provide a $1000 annual subsidy for every child of a faculty member from birth to graduation." K. S. H.

University Training in Science. EDITORIAL. *Chem. and Ind.*, **46,** 1006 (Nov. 4, 1927).—An answer to "Procrustes, or the Future of English Education," by A. Pink. Pink maintains that college education is being dominated by lectures, "no better than gramophones," and research, "a powerful God, made in Germany." The ideal of a liberal education lies buried while "the young man leaves the University fashioned like a Grecian column, very tall, but also very narrow."

The editor calls attention to the fact that a good lecturer is an inspiration to his students; while his interpretation of the spirit of his science, his discussion of modern applications, enables the students to see and learn what they never could without his aid. The scientific method, acquired in preparing for and carrying through a piece of research, should be of much value in training the student to face the larger problems of citizenship and commerce. E. R. W.

Sprayed Metal Forms Protective Coating. S. G. ROBERTS. *Compressed Air Mag.*, **32,** 2215–9 (Nov., 1927).—The surfaces of articles made of iron, steel, stone, wood, plaster, lead, porcelain, leather, or paper may be easily and well protected from oxidation by the application of aluminum, brass, bronze, tin, or zinc. These metals, in the form of wire, are melted in an oxy-acetylene flame and blown in a finely divided form into the surface pores of the material to be protected. The metallic layer thus applied

does not tend to crack or to scale off under working conditions, as often happens with ordinary galvanized surfaces. E. R. W.

Making Ammonia from Two Common Gaseous Elements. C. H. VIVIAN. *Compressed Air Mag.*, **32**, 2253–6 (Dec., 1927).—An interesting, detailed, and well-illustrated article dealing with the production of ammonia in the large hydro-electric plants at Niagara Falls, N. Y. One plant has a daily capacity of 10 tons of anhydrous ammonia. Nitrogen is obtained from the air and hydrogen from electrolytic cells where for years it was allowed to escape as a useless by-product. E. R. W.

Chemical Education in Canada. N. A. CLARK. *Chem. Bull.*, **14**, 306–7 (1927).—Treatment of the student by Canadian Universities resembles that in England so far as "putting him on his own" is concerned. The Canadian system does not take the responsibility passed by the freshman to his instructor when he said, "It's up to you to learn me."

While the colleges in the United States seek to salvage the derelict student, the Canadians seek the outstanding man. "Honors Courses" give him greater freedom and greater opportunity. Often his work on such courses starts in his first year of college. In some colleges honors students are permitted to do some research during their last undergraduate year.

Graduate work in Canada stresses the research and thesis more than is usual in the United States. The graduate student is less distracted by frequent examinations so has more undisturbed time to think for himself. B. C. H.

"Better Teaching in . . . High Schools." JOHN L. TILDSLEY. *School*, **39**, 233–6; 285–7 (1927).—The October (1927) Bulletin of High Points, published by the New York City Board of Education, was entirely given to the subject at the head of this abstract with a subtitle, "Its Characteristics, the Part Played by Teachers, Chairmen, Principals and Superintendents in Its Production."

The basis for the content and findings reported was; some 2000 letters from high-school boys and girls, and judgments of teachers and administrators.

Characteristics of the most desirable teacher according to the pupils include: Friendliness, sympathy, patience, fairness, humor, frankness and sincerity, cheerfulness, enthusiasm, thoroughness, and clearness.

Superintendent Tildsley considers there are three levels of teaching: First, the fact-imparting sort which measures its success by test passing; second, the illuminating teaching which, however, rates information supreme; and third, the "vital, vitalizing, creative" teaching which makes over pupils "by discovering in them and fostering hitherto unrecognized powers and aspirations."

He further emphasizes that, "Teaching that does not touch the *emotions* seldom leaves a lasting impression." B. C. H.

A Declaration of Independence for Public Education. HENRY SUZZALLO. *Bull. Am. Assn. Univ. Profs.*, **13**, 503–5 (1927).—Should "the man who signs the pay check be the one to decide what should be taught in the schools and colleges?"

"Does the patient who pays the hospital bill decide what therapeutics and operative procedures should be a part of the treatment?"

"Shall the political party or whoever gets control of our schools be permitted to use them for propaganda?"

"Shall the people not be taught how they may keep their schools as free as possible from partisan politics, or partisan religion?" B. C. H.

Foreign Light on American Education. VIRGINIA C. GILDERSLEEVE. *Bull. Am. Assn. Univ. Profs.*, **13**, 506–9 (1927).—European education, in the scholarly field, produces far more leaders of absolutely first rank than does America.

Reasons advanced for this failure of American Education are: In America we think too much of the individual, while in Europe they think primarily of learning—"a heritage to be enshrined and guarded." Europe teaches her best, we teach our average student.

American teachers are too kind-hearted to get the maximum effort from their students. American teachers are even accused of being "often afraid of our children." So "American pupils rarely learn what really hard work is."

Europeans are more confident of their examining ability and so are willing to stake more upon it. Over there courses, lectures, and classes may or may not be attended. It is believed the examination will reveal the scholarly attainments acquired without the bookkeeping we Americans indulge in as a part of our student's college history.

The author feels there is promise for American education in the movements which are using: Special honors courses, final comprehension examinations, external examiners, selective admission, etc. B. C. H.

Local Activities and Opportunities

Cornell University. The Non-Resident Lecturer in Chemistry at Cornell University, under the George Fisher Baker Foundation, for the second term of the present University year will be Professor George Barger of the University of Edinburgh who will lecture upon "Some Applications of Organic Chemistry to Biology."

The Non-Resident Lecturer for the first term of the University year 1928–1929 will be Professor Hans Pringsheim of the University of Berlin, who will lecture upon "The Chemistry of the Monosaccharides and Polysaccharides."

The Non-Resident Lecturers are provided with a private research laboratory, and Cornell University will be glad to extend the privilege of the department of chemistry to visiting chemists who may wish to carry on research under the direction of the Lecturers. Since space in this research laboratory is limited, it is suggested that those who may desire to secure places in it for any particular term, enter application for such accommodation with the department of chemistry at as early a date as possible.

Carnegie Institute of Technology. Dr. Thomas Stockham Baker, president of the Carnegie Institute of Technology, in Pittsburgh, expects to spend six weeks in Europe during February, March, and April of 1928 to organize plans for the Second International Conference on Bituminous Coal at Pittsburgh. The first conference, it will be remembered, was held in November, 1926, under the auspices of the Carnegie Institute of Technology, and was attended by 1700 delegates and leading fuel scientists from thirteen different countries. The second conference, which will be held under the same auspices, is scheduled for the week of November 19, 1928. President Baker's itinerary will include visits to scientists throughout Europe.

In connection with the preliminary plans being formulated by President Baker and his associates, it is further announced that a definite decision has been made to include the subject of "synthetic fertilizers from coal" in the program for the second conference. Other subjects to be considered will probably include the latest developments in obtaining substitutes for gasoline from coal, power from coal, low- and high-temperature distillation processes, smokeless fuel, gasification of coal, utilization of coal-tar products, and coal in relation to the production of fixed nitrogen.

Formal letters of invitation to be officially represented at the 1928 meeting have been sent to the ambassadors, ministers, and chargés d'affaires in Washington of the following countries: Argentina, Belgium, Brazil, Chile, Cuba, France, Germany, Great Britain, Italy, Japan, Mexico, Peru, Spain, Austria, China, Czechoslovakia, Denmark, Greece, Hungary, Norway, Panama, Poland, Sweden, Switzerland, Netherland, and Roumania.

North Carolina State College. Dr. Frank E. Rice, who has been professor of agricultural and biological chemistry since 1924, and who was chairman of the chemistry department this year, resigned his position with the close of the last term and has accepted a position as executive secretary of the Evaporated Milk Association with headquarters in Chicago.

Dr. A. J. Wilson, professor of analytical chemistry, has been appointed chairman of the department for the remainder of the session.

University of Pittsburgh. Professor Alexander Silverman, head of the de-

partment of chemistry of the University of Pittsburgh, was tendered a dinner by the students and faculty of Bryn Mawr College in Rockefeller Hall, Thursday, January 12th at 6:30 P.M. Following the dinner he delivered an illustrated lecture on "Glass: One of Man's Blessings." The Science Club of Bryn Mawr held a reception for Professor Silverman after the lecture.

Amherst College. A new chemical laboratory has just been promised to Amherst College by Mrs. Henry Moore of New York City and her two sons, Messrs. Edward Small Moore and Paul Moore. This building is to be erected as a memorial to the late William Henry Moore of the class of 1871 at Amherst College, a well-known Chicago lawyer.

Mrs. Moore's gift will satisfy a need long felt in the chemistry department. The Fayerweather Laboratory, the present chemistry headquarters, was built in 1893. It was excellent for that period and considered entirely adequate. But the needs of both the physics and chemistry departments have changed.

Plans for the new laboratory are now being drawn up and should be completed by spring. A site has not yet been selected, but it is supposed that it will be somewhere near the present laboratory. It is thought that the new building will be ready for use about a year from next fall. The probable cost of the laboratory is not known, but similar buildings at Wesleyan and Massachusetts Agricultural College have cost between $300,000 and $400,000. It is expected that the old laboratories will be done over to meet the needs for large lecture and class-rooms. The building of the new laboratory does not at all indicate an expansion on the part of the college, but rather a provision for relief of the crowded and congested condition in the chemistry department.

Minnesota Section, A. C. S. At the last meeting of the Minnesota Section of the American Chemical Society the following elections were made:

Senate of Chemical Education: M. A. Gray, Chief Chemist, Pillsbury Flour Mills Co., Minneapolis, Minnesota; Mr. Nordstrom, Crookston High School, Crookston, Minnesota; R. E. Kirk, School of Chemistry, University of Minnesota, Minneapolis, Minnesota.

Contributing Editor, JOURNAL OF CHEMICAL EDUCATION, G. B. Heisig, School of Chemistry, University of Minnesota, Minneapolis, Minnesota.

The present officers of the Minnesota Section are:

President, M. C. Sneed, School of Chemistry, University of Minnesota, Minneapolis, Minnesota.

Vice-President, F. E. Exner, Carleton College, Northfield, Minnesota.

Secretary, R. E. Kirk, School of Chemistry, University of Minnesota, Minneapolis, Minnesota.

Treasurer, R. E. Montanna, School of Chemistry, University of Minnesota, Minneapolis, Minnesota.

Councillors, C. A. Mann, School of Chemistry, University of Minnesota, Minneapolis, Minnesota; R. A. Gortner, Division of Agricultural Biochemistry, University of Minnesota, St. Paul, Minnesota.

N. E. A. C. T. The New England Association of Chemistry Teachers held its 108th meeting at Pawtucket, Rhode Island, on January 28th. The program follows:

10:00 A.M. Meeting at Rhode Island Branch of The Corning Glass Works, 1193 Broad St., Central Falls.

11:45 A.M. Inspection of the Pawtucket Senior High School Building.

12:45 P.M. Luncheon in Cafeteria.

1:45 P.M. Business Meeting and Address of Welcome by Lucius A. Whipple, Principal of Pawtucket Senior High School.

2:05 P.M. "Some Aspects of Glass Manufacture," Dr. J. E. Hostetter, Manager, Rhode Island Division, Corning Glass Works.

2:35 P.M. "Humor and Surprise as

Teaching Factors," Mr. C. H. Stone, English High School, Boston, Mass.

3:15 P.M. Motion Pictures, "The Manufacture of Glass."

Selections by High-School Band.

Ohio State University. The Eighth Annual Ohio State Educational Conference will be held at the Ohio State University, April 12, 13, 14, 1928. The program is now essentially complete.

Thirty-two out-of-state speakers, most of them with national reputations, will appear on the programs of the Eighth Annual Ohio State Educational Conference, April 12, 13, and 14, 1928.

Speakers for the general programs are Clarence C. Little, President, University of Michigan; Glenn Frank, President, University of Wisconsin; W. O. Thompson, President Emeritus, Ohio State University; J. Paul Goode, Professor of Geography, University of Chicago; and O. T. Corson, former Director of Education for the State of Ohio.

Out-of-state speakers at the twenty-nine sectional meetings during the three days include:

John J. Maddox, Superintendent of the City Schools, St. Louis. (City Superintendents' Section).

William McAndrew, Editor of *Educational Review*. (City Superintendents' Section.)

Herman Adler, Director of the Institute for Juvenile Research, Chicago. (Clinical Psychology and Special Education.)

R. L. Lyman, University of Chicago. (English.)

John R. Clark, New York University. (Mathematics.)

Charles Farnsworth, Teachers' College, Columbia University. (Music.)

V. A. C. Henmon, University of Wisconsin. (Educational and Intelligence Tests; Teacher Training.)

E. G. Blackstone, University of Iowa. (Commercial Education.)

L. C. Marshall, University of Chicago. (History.)

A. T. Walker, University of Kansas. (Latin.)

Lee Driver, State Department of Pennsylvania. (County Superintendents; Village and Consolidated School Superintendents.)

Alphonse Iannelli, Art Institute, Chicago. (Art.)

F. B. Knight, University of Iowa. (Educational and Intelligence Tests.)

Lois Hayden Meek, Educational Secretary of the American Association of University Women. (Elementary Teachers.)

J. Paul Goode, University of Chicago. (Geography.)

Catherine Blunt, University of Chicago. (Home Economics.)

Grant M. Hyde, University of Wisconsin. (Journalism.)

P. H. Hagboldt, University of Chicago. (Modern Language.)

Francis G. Blair, State Superintendent of Public Instruction, Illinois, and former president of the National Education Association. (Parent-Teacher Association.)

George F. Womrath, Business Superintendent of Schools, Minneapolis, Minnesota. (School Business Officials.)

A. C. Kinsey, Indiana University. (Biological Science.)

Robert W. Selvidge, University of Missouri. (Industrial and Vocational Education.)

Harvey Lemon, University of Chicago. (Non-Biological Science.)

W. T. Bovie, Northwestern Medical School. (Joint Biological and Non-Biological Science.)

Eata Sherman, Detroit, Michigan. (Physical Education.)

Jessie Burrall, Stephens College, Columbia, Missouri. (Religious Education.)

A. H. Bell, Gary, Indiana. (School Business Officials.)

Mildred Pope, Girard College, Pennsylvania. (School Librarians.)

Henry H. Howett, Washington, D. C. (Special Education.)

In addition to the above-named out-of-

state speakers, approximately seventy-five prominent Ohio school teachers and executives will appear on various programs.

The Ohio State Educational Conference is rapidly taking on a national aspect.

Oberlin College. Assistant Professor John Wolfenden has been called to an important position in Oxford University, England, taking charge of the sciences in Exeter College. John Vaughen, just now completing his work for the doctorate at Johns Hopkins, will finish the year in Professor Wolfenden's place.

The chemistry department announces a number of fellowships and scholarships for 1928–29. The Charles M. Hall Research Instructorship at $2000.00 is open to a man who has recently taken his Ph.D. degree and who has some interest in the art of teaching. The Instructor spends three-fourths of his time in joint colloid research with Professor Harry N. Holmes and one-fourth as a "teaching apprentice." After one year the Fellow goes out to teaching or industry and another is given a year's training. Doctor Evan Boss of the University of Illinois is the 1927–28 Research Instructor.

The Grasselli Fellowship has been offered for six years, paying $500.00 and free tuition and fees. Approximate total value about $850.00. The candidate must be a college graduate with four years of chemistry, a year of physical, a rough reading knowledge of German or French, and a background of cultural courses. It is expected that, in addition to certain required graduate courses, the Fellow will spend half of his year's time on research, looking forward to a Master's degree at the end of one year.

A Graduate Assistantship at $750.00 and free tuition and fees for fifteen weekly clock hours of teaching in the Freshman laboratory is open to college graduates prepared as required for the Grasselli Fellowship. In two years the assistant is expected to earn the Master's degree and have well over a year's graduate work to his credit. Research is a part of the training. Approximate value, $950.00 yearly.

Two Graduate Scholarships, giving free tuition, equivalent to $300.00 are available for Master's degree candidates.

Lexington Section, A. C. S. The 124th regular meeting was held at the University of Kentucky, Tuesday, Jan. 24, 1928. Dr. William J. Hale spoke on "The Farm as a Feeder to Chemical Industry."

Dr. Hale is director of organic research for the Dow Chemical Co., and a representative of the National Research Council.

A luncheon was served at the Phoenix in honor of Dr. Hale.

University of Florida. The Science Section of the Florida Educational Association held its annual meeting in Tampa on December 28th. The meeting was well attended by science teachers from all parts of the state. The program was as follows:

"The Conquests of Science," by A. P. Black.

"Teaching High-School Physics," by Prof. Henry Edwards.

"Chemical Calculations in the High-School Course," by Prof. Rollin Ebinger.

"Regulations Governing the High-School Essay Contest," by S. K. Love.

"Teaching General Science in Junior High School," Prof. G. W. Elhuff.

Round-table discussion, "Problems of the Science Teacher."

Prof. A. P. Black, University of Florida, served as Chairman of the Section.

University of Chicago. Professor Arthur H. Compton of the physics department was awarded the Nobel prize in physics for 1927, sharing it with Dr. C. P. R. Wilson, of Cambridge University. This is the third Nobel prize awarded to men connected with the physics department of the University of Chicago, the first having been awarded to Professor Michelson and the second to Professor R. M. Milliken for work done at the University of Chicago, but after he had joined

the California Institute of Technology at Pasadena.

Professor J. W. E. Glattfeld and Professor B. H. Nicolet attended the Symposium on Organic Chemistry at Columbus, Ohio, in the Christmas vacation.

Dr. Irving E. Muskat, Ph.D., of the department, has been appointed research instructor to succeed Dr. Hellerman who received a call to Johns Hopkins University in September.

Professor Fraenkel, of the University of Vienna, gave an address on "Synthetic Drugs" before the medical, biological, and chemical departments on Wednesday, January 11th.

Dr. Hrdlicka, Chief of the Department of Physical Anthropology of the U. S. Government and recently Huxley Lecturer in London, gave an open lecture on "The Glacial Life and Its Relation to Man," free to the public, under the auspices of the Chicago Section of the Sigma Xi Society, on January 24th, in Mandel Hall at the University.

Professor W. A. Noyes, Jr., recently lectured at Urbana, Illinois.

Professor B. B. Freud, of Armour Institute, received the Ph.D. degree in chemistry from the University of Chicago at the December convocation. Miss Georgine Moerke received the degree at the same time and is now chemist for the Detroit Municipal Tuberculosis Sanitarium, located near Detroit, Michigan.

Mr. John D. Xan, Ph.D. in chemistry in 1926, is now professor of chemistry at Battle Creek College. That institution has recently received an endowment for research fellowships.

Dr. Ethel M. Terry has accepted an appointment as Research Associate in the department of chemistry and will be free to devote her time to her research problems.

Cincinnati Section, A. C. S. The 295th regular meeting of the Cincinnati Section of the American Chemical Society was held in the Chemical Auditorium of the University of Cincinnati, on Wednesday evening, January 25th.

The speaker of the evening was Dr. Wm. J. Hale, Chemical Director of the Dow Chemical Co., Midland, Mich., and Secretary of the National Research Council, Washington, D. C. He presented a paper on "The New Synthetic Process for the Manufacture of Phenol."

Before joining the Dow Chemical Co., Dr. Hale was associate professor at the University of Michigan where he gave courses in general and organic chemistry. Since he became Chemical Director of the Dow Chemical Co., many improvements have been made in their manufacturing procedure and new manufacturing methods have been developed. In addition to his responsibilities at Midland, for the past year and a half, he has been secretary of the National Research Council.

Pennsylvania State College. The Second Annual Priestley Lectures in Chemistry were given, during the week of January 16th–20th, by Dr. Samuel L. Hoyt of the Research Laboratory of the General Electric Co. The general subject of the lectures was "The Physical Chemistry of Metals and Alloys." Dr. Hoyt explained the applications of the phase rule in one-, two-, and three-component systems. He also pointed out the relations between the physical properties and the constitution diagram of alloys, and discussed some of the newer alloys such as duralumin and stainless steel. The Phi Lambda Upsilon honorary chemical fraternity gave a banquet, on January 20th, in honor of Dr. Hoyt.

Dr. Gerald L. Wendt, Dean of the School of Chemistry and Physics, has resigned to become Director of the Battelle Memorial Institute at Columbus, Ohio. He will take up his new duties about July 1st. The School of Chemistry and Physics, under the administration of Dean Wendt, has undergone a marked development along many lines and it suffers a severe loss in his resignation. No successor has, as yet, been appointed.

Syracuse University. The Syracuse Section of the American Chemical Society and the department of chemistry of

Syracuse University will join in staging the Annual Exposition and KemSho, May 19th–20th. Over 1000 visitors attended the exposition last year, including 150 high-school teachers and students from out of town.

October 19th–20th, the Rochester, Buffalo, Ithaca, Schenectady, and Syracuse Sections of the A. C. S. will hold an intersectional meeting in Syracuse as guests of the University. Tentative plans call for a symposium on Cellulose, a half day of general papers, an evening of entertainment, and attendance at the Syracuse-Nebraska football game.

The class in elementary chemistry, which numbers about 700, is being studied intensively from several angles. The segregation of those who have had high-school chemistry from those who have not has proved to be highly satisfactory. After several experiments in sectioning, on the basis of ability, the final semester marks indicate that the highest and lowest quarters of the class can be identified at the beginning of the course with an accuracy of about 70%. Objective examinations are given periodically and are increasing in favor among both students and instructors.

Appointments to half-time graduate teaching positions will soon be made for 1928–29. These positions carry a salary of $750, free tuition and all laboratory fees, and the opportunity to study for an advanced degree.

Health Measures Make City Death Rate Lower. Death rates in the city are now lower than they are in the country because preventive health measures in cities reach and benefit a larger proportion of the inhabitants than is the case in rural areas.

This observation was voiced by Dr. Henry F. Vaughan, health commissioner of Detroit, at a recent conference for race betterment at which measures for the improvement of the human race were discussed by physicians, health workers, statisticians, and research men of many branches of science.

Altering the immediate environment under which man lives may affect whole communities, Dr. Vaughan pointed out. For instance, the substitution of a pure water supply of a city for a polluted one protects all its citizens, although thousands may be wholly ignorant of what has been done.

"Of one thing I am convinced, however," Dr. Vaughan declared, "and that is that there are those who cannot be made over into desirable citizens by improvement in environmental conditions. The continued reproduction of these should be checked. They reproduce their kind abundantly and without any sense of responsibility. Statisticians say that the criminal and moron classes are multiplying at a rate far beyond that of the population at large. They include the criminal classes and those deficient in intellect, and in a few of those who intellectually are at a par or above the average. I want to state most emphatically that neither education, even the highest education, nor perfect environmental conditions absolutely prohibit the development of undesirable propensities. This was shown a short time ago by the fact that two University graduates in Chicago were guilty of a most revolting crime."—*Science Service*

Recent Books

A Brief Outline of the History of Science. J. G. F. DRUCE, M.Sc. The Chemical News, Ltd., Merton House, Salisbury Square, E. C., London. First edition. 1925. 141 pp. 11.2 × 18.5 cm. $1.00.

The sciences occupy much attention in the schools and colleges in these days. Preference seems to be held for general science and not any particular science, but whatever the thought may be there isn't any question but that a concise, reliable course on the history of science, in general, will add much to a school or college curriculum.

The writer became deeply interested in the above publication by Dr. J. G. F. Druce, of London, who is a student of science in a broad sense, an investigator, and a trained writer. The favorable impression that the author of these lines received as to the excellence of the little book has prompted him to invite the attention of other science students to it. Teachers of science subjects will find it up-to-date. There are more exhaustive treatises on the history of science, but where something concise and accurate in regard to it is sought the present volume will prove most satisfactory and is bound to win high favor.

EDGAR F. SMITH

Handbook of Chemistry and Physics. CHARLES D. HODGMAN, M.S., associate professor of physics at Case School of Applied Science, and NORBERT A. LANGE, Ph.D., assistant professor of organic chemistry at Case School of Applied Science. Twelfth edition. Chemical Rubber Publishing Co., Cleveland, Ohio, 1927. xi + 1112 pp. 16.85 × 11.10 cm. $5.00. Special price to students, $2.50.

It is more or less conceded that engineering handbooks have served their purpose but have been, nevertheless, an evil influence. This has not been true of science handbooks. The difference is a fundamental one. The engineering handbook contains a great many empirical formulas which are useful only within a narrow range. The engineering student is taught to accept, without question, many statements in the handbook; therefore, he often extends the use of a formula far beyond its intended field. Sudden and certain disaster results. The science handbook, on the other hand, attempts to stick to scientific facts. It only approaches this ideal, but the results are satisfactory.

The "Handbook of Chemistry and Physics," by C. D. Hodgman and Norbert A. Lange, is the outstanding science handbook of today. The mere fact that it includes tables of both chemical and physical properties makes it of unique value to the chemist and the chemical engineer. It is well known that chemistry today includes the major part of physics. The combination of data in a handbook is a natural and necessary development. A handbook cannot be complete because it must be a convenient and ready reference. In this respect it does not compete with Washburn's famous "Critical Tables." The accuracy of the data is excellent and the selection of data is especially good for the average student.

In brief, this book has the hearty recommendation not only of the reviewer but of thousands of other readers.

D. B. KEYES

Laboratory Manual of Inorganic Chemistry and Elementary Qualitative Analysis. C. C. HEDGES AND H. R. BRAYTON, Agricultural and Mechanical College of Texas. D. C. Heath and Co., New York. First edition. 1927. 233 pp. 16 × 22.7 cm. $2.50.

As indicated in the title and preface, this manual is designed for a college course which combines general chemistry with qualitative analysis, involving three to five hours per week of laboratory work and extending over a three-term college session. The large number of such manuals already in print induces a reviewer to look for new or unusual features, either as to choice of material or its presentation.

The book is divided into three parts: Part I, which is devoted to the general principles of chemistry; Part II, entitled "Elementary Qualitative Analysis," which deals with the reactions of the ordinary metallic ions; and Part III which embodies the accepted procedures for the separation and identification of both metallic ions and acid radicals.

Some features of the book deserve special mention. (1) It involves the "start-stop" method of laboratory instruction in which the instructor explains the experiment immediately after it has been performed by the class. In the reviewer's opinion this method retards and discourages the superior student, though it no doubt benefits the slow or mediocre student by doing much of his thinking for him. On the other hand, it affords an opportunity to stress certain points which might otherwise go unnoticed. (2) The exercises in Part I are printed on *perforated gummed sheets*, to be detached by the student and pasted in a permanent notebook. This eliminates useless copying of procedures and the specific questions on each experiment, to be answered by the student, makes the grading of laboratory notebooks simple and intelligent. Part II is interleaved with blank sheets for laboratory quiz purposes. The qualitative analysis blanks in Part III insure uniformity and directness in reporting the results of unknowns. (3) The pointedness of the experiments is very striking; and the tabular method of arranging data helps to drive home the fundamental principles. One is, however, struck by the total absence of illustrative figures. This lack is offset by directions of unusual clarity, as is illustrated by the experiment on the density or molecular weight of oxygen on page 30. A large number of thought questions and problems for practice are included in the Appendix.

The optional experiments on the analysis of soap, vegetable oils, urinalysis, electroplating, etc., while interesting as lecture demonstrations perhaps, seem of doubtful value as laboratory experiments in a course of this scope where the available time is often limited. The equations listed on pages 178–96 are valuable for their sequence, but would be more valuable to the student if they had been left to him to balance. As a rule, students do not get enough practice in the balancing of equations. The uncertain cobalt-aluminate test for aluminum is retained; the authors have, on the other hand, included such positive tests as the dimethylglyoxime test for nickel and the nitroso-*beta*-naphthol test for cobalt. Typographically the book is well-nigh perfect; but it deserves a better binding than the poor cardboard cover in which it has made its first appearance.

By reason of its flexibility of adaptation and its plan which eliminates much of the drudgery of paper work for both instructor and student and thus renders the work more thorough and intensive, this manual deserves commendation.

T. F. BUEHRER

The Making of a Chemical, a Guide to Works Practice. E. I. LEWIS, M.A. (Cantab.), B.Sc. (Lond.), and GEORGE KING, M.Sc. (Birm.), F.I.C. John Wiley & Sons, Inc., New York, 1927. x + 270 pages. 13.5 × 21.5 cm. 27 figs. $4.00 net.

This book is an attempt to give the reader an insight into works practice and works conditions with special reference to the chemical industries. At the same time the underlying principles and the economic aspect are presented in such a way that they could equally well be

applied to other industries and lines of business. The radical departure in spots from the dignified language of the average text is in rather strange contrast to other parts of the book which are nothing more than lists of short statements regarding processes or equipment. The book is better suited, although by no means entirely so, to British than American readers because of the more frequent reference to British books, industries, etc.

It covers an amazing amount of ground by the simple expedient of mentioning one thing after the other much as a dictionary does, but without the dictionary's detail.

It is very doubtful whether the average student or teacher would derive much benefit from the book unless he has had some works experience. It is through that that the importance of the little things become noticeable. Every works manager knows that nearly all plant troubles are little ones when they start but a lot of little ones can make a big wreck. Here then lies the chief value of the book—a collection of little trouble makers hardly ever mentioned in textbooks and certainly not between the covers of any one book. It describes the facts that the average man learns only by experience.

As a book for supplementary reading for chemistry students there is a place for the work, especially if taken in connection with actual factory work.

CARL HANER

Beginning Chemistry and Its Uses. FREDERICK C. IRWIN, Head of the Department of Chemistry, The College of the City of Detroit, Detroit, Michigan, BYRON J. RIVETT, Principal of the Northwestern High School, Detroit, Michigan, ORRETT TATLOCK, Assistant Professor of Chemistry, The College of the City of Detroit, Detroit, Michigan. First edition. Row, Peterson & Co., Evanston, Illinois, 1927. vii +607 pp. 106 figures, 29 portraits. 13.5 × 19 cm. $1.60.

A first-year textbook in chemistry with the usual content and arrangement of subject-matter. The aims of the authors are to emphasize practical applications rather than technical theories, develop early topics gradually and clearly for the average pupil and to explain necessary technical terms when they are first used. Definitions of terms are set in bold-faced type with much space to give special emphasis. The chapters are closed with summaries and question exercises.

The weak point of most textbooks is the mere giving of information and the failure to develop constructive thinking. What the pupil does with the information is the important thing. The questions at the close of the chapters are so necessary to compel practical thinking that we could wish for more questions of this excellent type. "How can you prove that water is a compound?" Others such as, "What is a substance? What is an element?" however, only call for a repetition of the definition previously encountered. All such questions should be thoroughly tested by use before publication. In the question, "Why is calcium chloride used when generating hydrogen?" we wonder if the pupil will consider the chloride to be necessary. The reviewer had to search the text to find the answer to "Is the stability of water as a compound a matter of consequence to chemists?" These possible answers were located: "It (water) is also important because it may readily be decomposed into two elements. . . ." (p. 56). "Water is a very stable compound; that is, it does not readily or easily separate into its constituent parts. It stoutly resists decomposition" (p. 67).

A doubtful innovation is presented by briefly defining allotropy in connection with ozone, a rather unfamiliar substance, and giving only passing mention of it in connection with the more familiar elements, sulfur and carbon. Predicting the future trend of industrial chemistry is becoming more hazardous in these transitory days of rapid development. "As

water power is further developed in the United States, it is likely that the process (Birkeland-Eyde) will come into general use here." The last copy of *Industrial and Engineering Chemistry* tells us that the above process is to be replaced on its native heath by the Haber-Bosch process.

To a discussion of the structure of the atom and the theory of electrons the book devotes three pages. It can be used or disregarded as the instructor may desire for, quite in contrast to some recent books, the treatment is isolated and not woven integrally into the subject of valence and the periodic system.

The type is ten point which adds much to the very desirable quality of legibility as compared with the usual twelve-point type. Variations in the type faces are noticeable and damaged type shows on page one. Perspective instead of line drawings are used for the etched figures, with good contrast and originality. The other illustrations in electrotype were not cleaned frequently in the printing to prevent the too common muddy effects. The binding is excellent and the cover attractive. In many respects the work is very marked in its superiority to the earlier text by the same authors.

H. R. SMITH

Qualitative Analysis. W. F. F. SHEARCROFT. Oxford University Press, New York City, 1927. xvi + 71 pp. 16.5 × 11.5 cm. 35 cents.

The text proper has twenty pages devoted to theoretical discussions, and thirty-one pages devoted to the treatment of analytical methods. The book is bound in flexible cloth covers, carries no illustrations, and is printed in clear type on heavy paper. Very few typographical errors were observed, but one notes the occasional differences in spelling such words as "radical" and "shows" (radicle and shews) which may be expected in an English publication.

This rather unusual text is offered for use in preparatory schools. Part I, twenty pages, deals with such elementary ideas as: Atoms, Molecules, Salts, Acids, Bases. Then follows a discussion of Ions with a consideration of equation writing and the conditions under which precipitation occurs.

The practical part, Part II, begins with a consideration of methods of testing an unknown in the dry way; effects of heat, flame tests, borax bead tests, followed by the action of acids upon the substance under examination. Explanatory notes accompany. Then follow the successive schemes of analysis for the usual groups, the scheme for each being arranged in the genealogical table form which the author states has been proved the most readily comprehensible by beginning students. Copious notes are given with each group. One notes the absence of any treatment of an unknown when phosphates are present. Acid analysis is practically limited to the detection of the sulfate, nitrate, and chloride ions.

A record of an actual analysis covering four pages is given in detail showing how the various basic and acid ions are detected.

The author has taken considerable pains to impress upon the student the importance of avoiding the purely mechanical method of procedure and has stressed the value of questioning every step and reasoning every process, a method to be commended.

With the exception noted above, the little pocket manual covers, in an elementary way, the chief methods for simple analyses of unknowns. Teachers who believe that qualitative analysis, or some portion of it, should find place in the usual preparatory school course in chemistry and who can find time for such work may be interested in the small text. It does not seem sufficiently comprehensive to serve as a manual for the more extended study of the methods of basic and acid analysis in a longer course.

C. H. STONE

Tentative Course of Study in Elementary Science. GERALD S. CRAIG, Teachers

College Bureau of Publications, Columbia University, New York, 1927. 338 pp. 15 × 23 cm. In three booklets. 90 cents each.

The course of study is divided into three units. (Grades 1 and 2; 3 and 4; 5 and 6.) The place of science in the elementary school, the procedure in constructing a course of study, and the criteria for the selection of objectives are discussed in the introduction. The course has been planned to give continuity and sequence in the occurrence of objectives from one grade to the next. Each unit contains the following information for the class-room teacher: (1) Specific objective or the particular or specific information, habit, skill, or attitude which is recommended for the grade level; (2) larger objective, unit, conception, aim, generalization of which the specific objective is a part; (3) essential meanings to be developed; (4) information for the teacher; (5) suggested procedure or means of securing the objectives (described in great detail); and (6) references which are listed with the various units. Both teacher and pupil references are included. Questions about the unit and suggested activities and experiments are usually included in each unit.

S. R. POWERS

Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School. GERALD S. CRAIG, Teachers' College Contributions to Education, No. 276. Teachers' College Bureau of Publications, Columbia University, New York, 1927. 72 pp. 15 × 23 cm. $1.50.

Technics used by the author in developing a course of study in elementary science for the Horace Mann School are described. A tentative list of objectives for the science course of study were formulated using the following three criteria: (1) Certain objectives that are selected for elementary science should conform to those scientific conceptions, which, when understood, greatly influence the thought reactions of individuals and those which have modified thinking in many fields; (2) certain objectives that are selected for elementary school science should conform to those goals (information, skills, and habits) in science that are important because of their function in establishing health, economy, and safety in private and public life; (3) certain objectives that are selected for elementary science should conform to those facts, principles, generalizations, and hypotheses of science which are essential to the interpretation of the natural phenomena which commonly challenge children. The tentative list of objectives stated as "scientific conceptions" were secured by an examination of courses of study, professional literature, and authoritative treatises on science. The list of 82 objectives thus determined were then submitted to 188 educated laymen and their judgment secured as to their relative worthwhileness. Another basis of evaluating the objectives was secured through an analysis of 6806 children's questions. A third means of evaluation was on a basis of meanings developed in authoritative source books of science. In the final chapter the author makes certain pertinent applications and recommendations to those engaged in curriculum construction in science.

S. R. POWERS

The A B C of Hydrogen Ion Control. W. A. TAYLOR, Ph.D. The LaMotte Chemical Products Co., Baltimore, Md. Fourth edition. 1928. 124 pp. 18.5 × 26.5 cm. Illustrated. Free.

The foreword states that the present enlarged edition of this booklet is issued "with the hope that the added information will increase its usefulness to the present users of (LaMotte) equipment and also serve as a better textbook and guide to those just taking up the subject."

The introductory portion (pp. 7–24)

includes a discussion of the meaning of hydrogen-ion concentration and p_H, of the methods of p_H determination, and of titration errors. Pages 25 to 74, inclusive, deal with applications of hydrogen-ion control methods in some thirty industrial and scientific fields. The remainder is devoted to materials and equipment.

Numerous references to the literature are given. The professor or student of physical or industrial chemistry will find the booklet useful and suggestive.

O. R.

New Property of X-Rays Discovered. While the biologists attending the meeting of the American Association for the Advancement of Science were listening to accounts of newly discovered ways in which x-rays affect living tissue, the physicists heard about another new property of these rays. Dr. Fred Allison, of the Alabama Polytechnic Institute at Auburn, Alabama, told the American Physical Society how he had found that they change the effect of certain liquids and other substances on light.

Many liquids, such as a sugar solution, have the property of turning the plane of polarized light. Ordinary light consists of vibration in an indefinite number of directions, but when polarized the vibration is confined to one particular plane. If a beam of such light is passed through a sugar solution, it is still vibrating in one direction when it emerges, but in a different direction from that when it went in.

Dr. Allison has found that even liquids which do not ordinarily have this power gain it when exposed to x-rays. When liquids, or glass, are placed in the field of a powerful magnet, they gain this property, as discovered many years ago by Faraday. When x-rays are used in addition, says Dr. Allison, the rotatory powers of the liquids are increased, while in glass it is made to rotate in the opposite direction.—*Science Service*

Measures Electric Charge of Diphtheria Germs. The ability of a living diphtheria bacterium to pour poisons into the blood stream of humans bears a relation to the size of the charge of electricity which each bacterial cell carries, according to Drs. I. S. Falk, L. B. Jensen, and J. H. Mills of the University of Chicago.

Their electrical measurements can be made in a few minutes and with simple apparatus on cultures thought to be capable of producing toxin. The results are obtained much more rapidly than by time-consuming methods of animal experimentation.

The electrical method is based on the fact that the power of the bacterium to excrete poisons depends on the porosity of its outer wall. This, in turn, affects the electrical charge on the cell as a whole.

The observation is made by placing the suspected organisms in a small chamber between metallic plates charged to a definite electrical potential. The rate at which the bacteria cross the electrical field is then watched through a microscope. The virulence of the germs can be calculated by reference to the rate of "migration" of a strain of diphtheria of known toxin-producing power.

This new method is expected to speed up detection of cases of diphtheria, and to facilitate release from quarantine.—*Science Service*